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AN INQUIRY INTO THE NATURE AND CAUSES OF STATISTICIANS*

BY F. LESLIE HAYFORD

THE ELEVATION of standards of statistical work in this country has long been regarded as one of the major objectives of the American Statistical Association. From time to time proposals have been made that as a means to that end the Association classify and grade its members, so that even he who runs may read how good any given statistician is, and what degree of professional standing he is entitled to. I am skeptical of the efficacy of such measures. "A basic difficulty," as was pointed out some years ago by a Committee on Association Policy, "lies in the fact that *quality* in statistical work is vital, and exceedingly difficult to measure in its various manifestations . . . quantitative measurements (such as years of training or experience, publications, etc.) often seriously fail to reflect vital differences in quality. It would be a disservice to the profession if ratings promoted the advancement of the less fit, and it would be exceedingly difficult to furnish dependable ratings on the basis of quality."

Another difficulty, perhaps no less basic, is our inability satisfactorily to answer the question, What is a statistician? For statisticians cannot easily be described with exactness. They are not, as some writer erroneously said of the Methodists, "one people;" they are many kinds of people. This makes it exceedingly difficult, if not impossible, so to define and classify them as to make feasible a separation into appropriate grades and classes, neatly labeled and certified for quality and content. Books on statistics, even textbooks, give us little help. They are concerned with matters of statistical design, engineering, and production; with statistical raw materials, processes, and finished products; instead of with what might be called "personnel problems." But if, as has been aptly said, "fundamentally, statistics is a mode of thought," might it not be well to consider the statistician as Emerson looked upon the Scholar—as Man Thinking? Viewing him thus, what shall we say of his functions and characteristics?

* [illegible]

One of those aphorisms which states a general truth imperfectly is that a statistician is one who is versed in handling mass data. This says both too little and too much; it leaves us still in ignorance as to the essential manner of such "handling." The variety of places in which we find persons dealing with statistics, and the range of views that are held regarding them, have doubtless added to the difficulty of saying what in fact statisticians are. They have long been much belittled and much overrated. By some they are looked upon as mere dull dissectors of dead records; and by others as brilliant geniuses whose mathematic magic enables them to discover laws and even to penetrate the future. They have become indispensable in the physical, biological and social sciences; fixtures in government; invaluable to all who have axes to grind (which causes them to be seen on both sides of controversial fences). They are thought capable of proving and disproving anything. And they are sometimes inclined to believe themselves, if only given a real chance, better able to run businesses than the business men who persist in being so blind to their capacities. They are regarded with suspicion, with pity, with admiration, and even with awe. They are lauded, quoted as authorities, damned, and made the subject of ancient jokes. They are not only little understood by others; they insufficiently understand themselves. It is high time for them to examine their various aspects and conditionings, and say what place in the world they propose to fill.

The most obvious, and indeed the basic functions of a statistician constitute a trinity, with each part of which he cannot fail to concern himself. They are the assembling of numerical data, their analysis, and the interpretation of the results of such analysis. It often happens, in the division of labor resulting from a highly organized society, that not all of these three functions will be, or can be, performed by the same person. This, while making possible a greater quantity of output, has its disadvantages and dangers, and doubtless causes a good deal of bad statistical product. It is apparent when one thinks about it, though in practice it is sometimes overlooked, that those who assemble data ought to have some idea of the purpose for which the data are being assembled; for the methods of collection which are appropriate for one purpose may be quite inappropriate for another. It is important, too, that those who analyze statistics should know the nature of the data, their sources, and the methods used in their collection. It also would be well for those engaged in such analysis to know just why they are thus engaged, and to concern themselves somewhat with the possible inter

pretations that may be put on their results. And those who interpret statistical analyses should know something of the methods of the analyses and of the data used, if they would safeguard themselves against reaching wrong conclusions.

The user of statistical data which he himself has not assembled may be left in ignorance of the reliability of their sources, the care or lack of care with which they have been collected and arranged, or even of their exact meaning. Under such conditions of production of his raw material, the statistician, as Man Thinking, will be fully conscious of the dangers to which he is subjected, and will not rely too implicitly upon his mathematics to produce for him a dependable finished product. Now will be the time for him to bear in mind that warning in Eldertons' *Primer of Statistics* which is sometimes forgotten in the enthusiasm of "handling" data, namely, that "no amount of knowledge of refined statistical methods can ever give value to statistics that have been collected on an unsound plan." The dependence of accurate statistical data on precise definition, and on strict adherence to such definition in the assembling of the data, is too little stressed by many writers on statistics and even by some statistics-gathering agencies. This is unfortunate, because it adds to the difficulties of the statistician's self-education. He will have to learn, in some fashion, to be always careful to assure himself of the meaning and the quality of the data he uses, constantly remembering, as Robert E. Chaddock has warned him, that figures do not necessarily tell the truth, and that "it is never safe for purposes of comparison to accept published statistics at their face value without careful scrutiny of their limitations."

We cannot overlook the fact that users of statistics, statisticians as well as others,* are constantly in danger of contamination from the pernicious notion in general circulation that the greater the quantity of numerical data that is made available the more we shall know about the world we live in. An inexcusable amount of error has been let loose upon the world because faulty, misleading, or downright false data, by reason of their neat tabulation or their publication in a government report, have been taken at face value. And if, as I suspect, preparation for what is euphemistically called national defense generates a new statistical fever, some level-headed statisticians—men *thinking*—will be needed to keep statistically naive enthusiasts from confusing ships with shoes and sealing-wax and kings. Quality control of statistical raw material is going to be especially important in the present crisis.

The analytical function of the statistician is perhaps too well understood to require elaboration. That is where he chiefly glories in the exercise of his technical proficiency. It is there that his grasp of the mathematics of the new statistics will set him apart from his less expert fellow men. To be sure, he may at times, in his enthusiasm for form, somewhat neglect appropriateness of manner or of matter. In his higher state, however, he will criticise himself at every step, and by insistence on maintaining a rigid scientific skepticism avoid the pitfalls of trusting either his data or his mathematics too implicitly. In his less sophisticated state, before he is well seasoned, he may perhaps rashly risk his reputation by too great dependence on the slender reed of methodology and by giving too loyal allegiance to the doctrine that by formulas all things are possible, even the purification of tainted data. But that will be but a passing phase in his education, from which he will eventually emerge, perhaps battle-scarred, but wiser. And having emerged, he will listen again, and more attentively, to the professors, who before had seemed to be talking mostly about the mechanics of the trade. He will be inclined to agree with Horace Secrist that accurate knowledge of the statistical units used is quite essential; with Martin F. Fritz that "statistical manipulation cannot be expected to make up for bad sampling," with Jerome B. Cohen that "the continuous application of a large measure of common sense, caution and reasoning skepticism is by far the safest bulwark against error;" and with George W. Snedecor that "you cannot master statistics without practice."

Although it is in his analytical function that the statistician finds his most stimulating exercise, it is by his interpretation of the results of his analysis that he is likely to become most popularly known. It is through this interpretative function that he is supposed to arrive at answers, solve problems, discover "laws," and make prophecies. Except perhaps for the mathematical statistician, whose greatest contribution to statistics is said to be the development of theory and the devising of methods of analysis, interpretation is the goal at which the statistician's work is aimed. In the assembling and analysis of statistical data a thorough knowledge of the field in which one works is necessary. Back of all the figures are things or persons, about which the statistician must have something more than a smattering of knowledge. But in interpretation—in drawing inferences from statistics—this necessity is sometimes disregarded. Thus pseudo-statisticians often come to strange conclusions. The varieties of faulty inference, with some indication of their causes, are sufficiently touched upon in Professor Cohen's article

entitled *The Misuse of Statistics* in this JOURNAL for December 1938, to call for no discussion here. The expert statistician, of course, makes no such errors. He has been trained to question not only all his data, but every step of his analysis, and he views his every interpretation with as skeptical a scrutiny as though it were the work of his least respected fellow statistician. Even when he slips into prophecy—or forecasting, as it is commonly called in the field of business—he will protect his scientific soul by pointing out that statistics alone are not a sufficient basis for prophesying, and that he has had to make certain assumptions which time may prove unwarranted.

It is by this trinity of functions—the assembling, analysis, and interpretation of numerical data—that the statistician is chiefly recognized. But he has another office, essential to the most useful exercise of the other three; he must in some fashion be an author, a user of words as well as mathematics. It is here that difficulties will be met, compared with which those of statistical techniques will at times seem trifling, at least to his readers. The difficulties arise not only from what Sir Francis Galton called "the uncouth words" used in modern statistical description, but also from the failure of the courses which the statistician took at the university to reach quite this requirement of his work, although, to be sure, they drilled him in the jargon of the trade. Perhaps it would be hypercritical to say, with Sir Arthur Quiller-Couch, that jargon is "flaccid writing to which flaccid thought instinctively resorts;" but one wonders now and then what would happen to statistics if every statistician should strive half as hard to learn the use of language as he has striven to learn the use of formulas. Unfortunately, there will always be amateurs, or mere writers, who will seek to popularize the results of the statistician's work, and who in so doing will gild many a statistical lily. With their more facile writing and less careful thinking, and free of the inhibitions of the scientific attitude, they may so distort, or deliberately misuse and falsify, the statistician's work that a flood of lies will be put into circulation, for which the innocent statistician himself may get all the blame. Eventually, perhaps, this may force the statistician, in self-defense, to the intensive cultivation of the art of using language to reveal more clearly to others the secrets he goes to so much pains to discover for himself. It is not without significance that one of the sessions of this year's Annual Meeting of the Statistical Association is being devoted to a discussion of what is described as "principles and procedures for putting across business statistics reports." The implication is salutary—that in the field of business, at least, something must

be done better to bridge the chasm between the makers and the desired users of statistical reports.

I have said little, and that but indirectly, about the causes of statisticians. In the beginning, before statistics had become so popular as now, it is quite probable that numerical data were sought and used almost wholly because communities and individuals had a strong desire to know more about themselves and the world they lived in. Doubtless even then, however, there were some who sensed the value of statistics as means of supporting their sides of arguments and of justifying their actions or proposals. In later years the sciences, physical, biological and social, found statistics invaluable aids to understanding and discovery. But it has been the growing belief in the efficacy of figures to prove things, to provide answers to baffling questions, and to reveal the future, that has led to the present widespread use of statistics and statisticians. The child-like faith of the public, including businessmen, social reformers, politicians—even sometimes the intelligentsia—in the validity of numerical data has facilitated the application of statistics to all manner of ends. Opportunities for statisticians of various grades and shades have rapidly increased. And the institutions of higher learning, impressed by the demand for statistical methodology, have enlarged their facilities to meet this demand.

It is by no means clear just how much the formal teaching of statistics has been responsible for the present generation of statisticians. There still are many statistical practitioners who have had little or no formal instruction in the art, but who have acquired such proficiency as they possess through self-education, through the doing of statistical tasks, and through the direction, advice, and guidance of those who were more expert and experienced than they. That kind of training can be most effective; but it requires a special learning aptitude on the one side and a special teaching aptitude on the other. Such aptitudes are also necessary for real success in the more formal, or academic, teaching, and are not universal among those who take or those who give courses in statistics. Careful vocational guidance might prevent the adoption of statistical work as a career by some students who are neither temperamentally nor intellectually fitted for it. Not all persons can become good statisticians, no matter how many academic courses they complete, any more than all graduates of medical schools will become good physicians. How far vocational guidance should be applied in the making of teachers of statistics is another question, but it may well deserve the attention of those responsible for academic appointments.

Of course not all teaching of statistics is aimed at making statisticians. This may make the teaching of the elementary courses more difficult and at times less interesting both to teachers and to students. But if such courses were regarded as an essential part of education, and were designed primarily to lead men and women generally to be less statistically illiterate in their reading (even of newspapers) and in their conversation, then their teaching might well become of more absorbing interest to teachers and their study seem more vital to students. More practicing statisticians would not necessarily be bred in this way, but it might well be hoped that a greater degree of statistical sophistication would eventually prevail among college graduates at least.

It may seem a far cry from figures to fishing, but I have a notion that both teaching and learning might be helped if every instructor and every student should be a sympathetic reader and re-reader of Izaak Walton's little book *The Compleat Angler*, for the emphasis therein is similar to that which ought to be put upon the learning of statistics. "I tell you, scholar," says the fisherman-instructor, "fishing is an art—or, at least, it is an art to catch fish." And in another place he says, "come, . . . I will give you more directions concerning fishing, for I would fain make you an artist." To which his scholar answers, "Yes, good master, I pray let it be so." There is much expert and enthusiastic description, having, it seems to me, a parallel in statistics, of the different kinds of flies, and how to make them, and of the various other baits, and for what fish and under what conditions they are appropriate; together with wise counsel to the effect that to become an artist one must acquire skill by observation and much practice.

Statistical and others journals are perhaps a contributing cause of certain types or variants of statisticians. For they greatly tempt one at times to rush into print prematurely and in so doing to exhibit what one believes is his grasp of statistical technique. To the true scientist technique is only incidental to the attainment of the truth; necessary, perhaps, but not the end and aim of his research. Much of the discussion of technical procedures is, of course, valuable to other statisticians; but it might be well if the publication of statistical articles was made a more soul-searching matter, not to be entered upon lightly or without a good deal of critical examination and analysis by and of the author himself. I would insist, were it possible, that every statistician who was in any danger of writing for publication keep upon his desk where he must read them every day these words from a recent textbook on statistical methods:

"*The publication of results.* The first time you successfully complete a test of significance, using your own experimental data, you will feel an urgent need to report the whole process in your thesis or a journal article. A good way to get relief is to write it out in full, then file it away in your note book. If you have described your experiment carefully, it is likely that the only statistical report you need make is something like this: 'The 20 rats receiving treatment A gained an average of 8.3 grams more than those receiving treatment B. The standard error being 1.2 grams, the difference is highly significant'."[1]

The expanding rôle of government has of course had much to do with the creation of our present generation of statisticians. More than 800 of the members of the American Statistical Association, or something like a third of the total, are working in local, state or federal government agencies. More and more statistics are being made the basis of legislation and of governmental administrative policy. We have in this country not only a public avid for figures but also a statistically minded federal government, with a statistically minded Congress made up of men who are not statisticians. That in itself would emphasize the need of guarding truth in statistics and truth in statisticians—even the truth that is embodied in the confession "I don't know." But these are unusually important times. Many decisions are being made and many more will have to be made by those in government, and by those in business as well, which will have a vital influence upon the world in which we shall be obliged to live. It is imperative that those decisions be based upon information and inferences drawn therefrom which are as accurate and complete as possible. Statisticians, then, are confronted by unusual opportunities and must face obligations which cannot be viewed lightly. It will be so difficult for statisticians not to do harm—by sins of omission as well as by sins of commission—that the duty of maintaining high standards in their work will rest heavily upon them.

This is not going to be an easy or at all times a popular rôle. For it will require not only harder and more exact thinking than many of them may have been accustomed to, but also a highly critical attitude toward the work and statements of others, including fellow statisticians. So many misuses are made of statistics, both innocently and with malice aforethought, and so many more will be made under the stress of crisis or emergency, that it will be highly important for statisticians to undertake the job of being a sort of home guard to kill off statistical

[1] George W. Snedecor, *Statistical Methods*, p. 55.

fools and liars. This, however, must be the job of statisticians individually, rather than the office of some inquisitorial hierarchy. It is not by official censorship, even though it were to be created by so high-minded a body as the American Statistical Association, but by the tender conscience and motherwit of individuals that truth may be made to prevail.

Statisticians themselves will be exposed to dangers difficult to overcome. There will be the danger of too much hurry to know too many things; the danger of having to deal with too great a mass of data whose nature and quality are too little known; the danger of too great insistence on positive, unreserved conclusions; the danger of too naive a belief by themselves and others in the ability of statisticians to prophesy; the danger of too great confidence in purely mathematical processes; the danger of coming to think of the data only in terms of numbers, and thus of living in a world of unreality which makes mathematical results seem more valid or significant than they sometimes are.

Too much the practice of statistics has come to be looked upon as a business rather than as a scientific pursuit. This is not to be laid at the door of teachers of statistics, but rather to the users of statistics; and perhaps to a general and pervading malady afflicting many of our institutions of higher learning which caused Dean Woodbridge of Columbia to say that education "has produced enough excited individuals" but is "producing too few dispassionate scholars." Now if dispassionate scholarship is anywhere to be desired, it is in statistics, where the possibilities for evil are perhaps even greater than the possibilities for good.

This leads to yet another aspect from which I wish briefly to view the statistician—his spiritual side. There is something more to being a statistician of the "pure culture," to speak biologically, than having acquired a familiarity with statistical concepts and terminology, a ready knowledge of the uses and dangers of averages, correlation, standard deviation, sampling, degrees of freedom, chi-square tests, and all the other ideas and devices that constitute the tools of the statistical workshop; and even something more than having become expert in the uses of these tools. One may have all this knowledge and expertness and still lack something that is essential to what I have called the "pure culture."

Stressing the "truthfulness" of the ancient Greeks, R. W. Livingstone, President of Corpus Christi College, Oxford, says "they had the desire and the power to see the world as it is . . . the disinterested pas-

sion for contemplating things . . . Avoiding the didactic, they will not distort truth to suit personal bias; avoiding rhetoric, they will not sacrifice it to fine phrases; avoiding sentiment and fancy, they will not gratify their own or their hearer's feelings at the expense of truth; avoiding mysticism, they will not move away from facts into a world of emotions . . . It is the habit of looking straight and steadily at things, and describing them as they are, the very contrary of the habit of didactic comment and of rhetorical or emotional inflation." Now it is just this "spontaneous and effortless veracity" which the Greeks teach us that must be a part of every true statistician.

"Nothing great in science," declared Huxley, "has ever been done by men, whatever their powers, in whom the divine afflatus of the truth-seeker was wanting." Something of that "divine afflatus," I take it, inspired the founders of the American Statistical Association in their establishment of our society. To the rekindling of their spirit of devoted truth-seeking these times of crisis call us.

PROBLEMS OF STATISTICAL CONTROL—MILITARY ASPECTS*

By Richard O. Lang
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From the point of view of the amount and variety of statistical data available we are indeed much more fortunate than our predecessors in the emergency of 1917–1918. In his presidential address before the American Statistical Association, on December 27, 1917, Mr. Allyn A. Young said: "In this emergency we turned first to our existing stocks of statistical information and to the current statistical output of our government bureaus, and have realized, perhaps for the first time, how woefully incomplete and inadequate our federal statistics are. With our latest population figures seven years old, our latest statistics of manufacturing output three years old . . . , and with no information whatever respecting important fields of trade, we were in a state of statistical unpreparedness."[1] We are not now in the situation of having a census of population seven years old, a census of manufactures three years old, or no statistics whatever on trade. Results of the 1940 population census are being released at frequent intervals. Information on manufactures, wholesale and retail trade as well as housing, agriculture, mines and quarries collected in 1940 is being released daily. Weekly, monthly, quarterly and other periodic reports covering nearly every aspect of our economic life are being made available to us from government and private sources. We can say, therefore, of our existing stock and current output of basic statistics, that we are in a state of statistical preparedness.

In the emergency of 1917–1918 the statistical preparedness of the War Department was in no better condition than other government agencies. It was not so much that there was meager information available, but that there had been no formal statistical organization. It is entirely correct to say that there was no central statistical office in the War Department in which military statistics were assembled, compiled or analyzed. The War Department was small enough and the executives sufficiently well acquainted with each other so that it was possible to secure information through personal contact and acquaintance. With the rapid expansion of emergency work it was necessary to establish small statistical offices in the various supply branches of the military

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 26, 1940.

[1] "National Statistics in War and Peace," *Quarterly Publications of the American Statistical Association*, March 1918.

organization. Along with this movement to centralize statistical information in each of the branches there was established, under the leadership of Colonel Leonard P. Ayres, a central statistical organization in the War Department charged with the duty of compiling important statistics and preparing reports to guide the military authorities in coordinating the Army program. Just as other government agencies concerned with war preparedness realized the importance of having more information on the economic life of our Nation, so the War Department learned the need for and importance of military statistics. The experience of their statistical unpreparedness taught the policy-making authorities a costly lesson.

The need for and usefulness of military statistics during the World War emergency arose primarily from the almost insurmountable difficulties of procurement of equipment and supplies. Practically no planning for war-time procurement had been done during peacetime. Each branch or service of the military organization had its own procedure for buying equipment. This system, with all its inherent faults, was adequate to supply the needs of the armed forces during peacetime, but resulted in chaos during the emergency. The services were competing with one another for supplies and equipment. It took all the energies of the War Industries Board, the Priorities Committee and similar emergency agencies to reorganize the purchasing procedure for the duration of the war effort.

The inadequacy of procurement planning was felt so strongly during the emergency of 1917–1918 that legislation to correct this situation was passed by the Congress before the Armistice was two years old. The National Defense Act was amended in June 1920 to provide for an Assistant Secretary of War who was "charged with the supervision of the procurement of all military supplies and other business of the War Department pertaining thereto and the assurance of adequate provision for the mobilization of material and industrial organizations essential to war-time needs."[1]

That legislation itself does not solve problems was certainly true of this amendment. Those persons in the military organization who referred constantly to statistical information to assist them in making

[1] The National Defense Act, Sec. 5a. June 4, 1920 (41 Stat. 761).

The first two paragraphs of section 5a of the National Defense Act as amended in June 1920, were amended by an Act approved on December 16, 1940. Duties referring to procurement formerly imposed on the Assistant Secretary of War are now imposed on the Secretary of War. The appointment of an Under Secretary of War was authorized in this new Act and the Secretary may assign the duties in connection with procurement to either the Under Secretary or the Assistant Secretary. Mr. Robert P. Patterson is now the Under Secretary of War and is still carrying on his responsibilities as Assistant Secretary. To date no Assistant Secretary has been appointed.

important decisions during the war effort, recommended that the War Department establish a permanent statistical agency. Colonel Leonard P. Ayres, in his report for year ending June 30, 1919, as Chief Statistical Officer of the General Staff, strongly recommended the creation of a central clearing house for statistical information originating in the various branches of the War Department. He indicated that such a statistics branch would make an important contribution to military science by assisting in the solution of fundamental problems on which statistical data could be made available. It was believed that continual measurement of the work of the Army was of sufficient importance to the War Department that a statistical organization should be created. In spite of all these recommendations and in spite of the experience and lessons learned during the World War period, no adequate statistical agency was maintained. In 1935, fifteen years later, a report made by a committee of the Army Industrial College urged the immediate establishment of a central statistical organization to develop and improve the statistical data originating in the various branches of the War Department and to devise methods of analysis of these data. The recommendations issued in this report had the same fate as all previous recommendations.

At the beginning of the present emergency there were three branches of the Office of the Assistant Secretary of War engaged in activities relating to procurement: (1) the Current Procurement Branch engaged in current purchasing; (2) the Planning Branch engaged in preparing plans for war-time procurement, including plans for industrial mobilization in war; and (3) the Statistics Branch engaged in the compilation, analysis and distribution of essential data on the progress of procurement and other related matters. The Statistics Branch was belatedly created upon the initiative of the Assistant Secretary of War in September 1939, while the Planning and Current Procurement Branches had been in operation since the amendment to the National Defense Act in 1920. The work of the Planning Branch both with reference to the planning for war-time procurement and for the mobilization of industry included few important statistical studies. If military statistics had been given the recognition which had so frequently been recommended, it would have been an important part of the regular work of the Office of the Assistant Secretary of War.

In accordance with the provisions of the amendment referred to above the chiefs of the branches of the Army charged with the procurement of supplies report directly to the Assistant Secretary of War regarding all matters of procurement. The eight supply branches, called

the "Supply Arms and Services," are the Air Corps, Coast Artillery Corps, Signal Corps, Corps of Engineers, Quartermaster Corps, Medical Department, Ordnance Department, and Chemical Warfare Service.

The first four of these branches in addition to being "services" are the "combat arms" or "tactical units" whose function in time of war are to engage in combat. The latter four branches are strictly "services," having to provide munitions, operate establishments and furnish technical services. The names of most of the branches indicate the kinds of equipment and supplies for which they are responsible. The supplies to be procured by the Ordnance Department and the Quartermaster Corps are not apparent from their titles. The Ordnance Department is charged with the procurement of munitions for the Army, such as ammunition, guns, bombs, tanks, etc. The Quartermaster Corps feeds, clothes, houses and transports the Army, as well as procures all supplies common to two or more branches. The Chiefs of the eight Supply Arms and Services are directly responsible for their own procurement activities including procurement planning. The rôle of the Assistant Secretary of War is that of supervisor. He prescribes the form and general content of plans to be submitted in the interest of a common basis, examines and coordinates them when submitted. The initiative of procurement rests with the Supply Arms and Services.

The statistical data which are used to measure the adequacy of the procurement program for purposes of control come from the following sources:

1. Troop Basis Tables—a mobilization plan which shows the ultimate troop objectives, the rate of mobilization month by month and the distribution of the troops by Corps areas. These tables show the numbers and types of troops to be mobilized by monthly periods.

2. Tables of Organization—the functional organization of each unit together with the detailed organization of each of its components.

3. Tables of Basic Allowances—tables which prescribe authorized basic allowances of organizational and individual equipment.

4. Requirements—a coordinated statement of supplies and equipment necessary to meet the plans indicated in the Troop Basis Tables, the Tables of Organization and the Tables of Basic Allowances.

5. Summary of Appropriations—the authorized fiscal program for which Congress has appropriated a specific amount of money.

6. Contract and Delivery Schedules—a compilation of the contracts for supplies and equipment with their accompanying estimated delivery schedules.

7. Production Program Control—frequent, periodic information on

actual deliveries of various items of equipment and supplies to be compared with the contract schedules.

Who is responsible for the data which we are calling "military statistics?" What is the relationship between the "top control" or policy makers and those charged with the responsibility for carrying out the policies and decisions? Very briefly the organization may be described as follows:

The Secretary of War, through the War Department General Staff, determines: (1) the magnitude of the military program; (2) the material which is essential to the proper conduct of that program, together with the design of the items; and (3) the quantities of such items needed divided into a time-rate-place schedule, such a time-rate-place schedule to include both initial and replacement requirements.

The General Staff determines requirements by prescribing the general method of computing Army (military) requirements, prescribing maintenance factors and the time elements involved in supplying troops. It approves the organization tables, equipment tables and allowance tables. The supply branches, under the direction of the General Staff, compute the Army requirements which are then submitted to the General Staff and approved in the name of the Secretary of War. A copy of these Army requirements is furnished the Assistant Secretary of War.

The supply branches, that is, the Supply Arms and Services, acting under the Assistant Secretary of War then convert these Army requirements into procurement requirements, taking into account the existing war reserves and the time factors necessary to transport the completed articles from the factory to the supply channels of the Army. Thus the Army requirements are computed under the direction of the General Staff and the procurement requirements under the direction of the Assistant Secretary of War.

More than two million different items are being procured by the Army. In such a purchasing program there are obviously some items which are more important than others, more difficult to produce or purchase. Furthermore, many of these items contain materials for which there is a limited supply. Certain raw materials are of such vital importance that the joint Army and Navy Munitions Board has as one of its principal functions the study of these materials. These raw materials are divided into strategic and critical materials.

Strategic materials are those materials vital to the national defense which must be procured entirely or to a substantial degree from sources outside the continental limits of the United States because the domestic

production is not sufficient in quantity or quality to meet requirements, and for which strict measures of conservation and control of distribution will be necessary. Antimony, mica, rubber, and tin are examples of strategic materials. Critical materials are those important to the national defense whose procurement will not present problems as grave as those raised by strategic materials because they are produced in quantity and quality sufficient, or nearly sufficient, to meet requirements, or can be replaced by substitutes, and for which less strict measures of conservation and control of distribution will be necessary. Cork, graphite, hides and leather, and wool are examples of critical materials. The Army and Navy Munitions Board, in addition, maintains a list of, and keeps under close study, other materials which might become strategic or critical. The continued study of the changing material requirements of modern warfare is an important task of the Army and Navy Munitions Board.

The accumulation of stock piles of strategic and critical materials was first authorized by the Act of Congress approved June 7, 1939. The purpose and intent of this Act, announced as the policy of Congress, is to provide for the acquisition of stocks of strategic and critical materials, and to encourage the development of mines and deposits of these materials within the United States, and thereby decrease and prevent wherever possible a dangerous and costly dependence of the United States upon foreign countries for these materials in times of national emergency. The present Congress has made at least six appropriations to assist the building up of stocks of strategic and critical materials.

The acquisition of supplies and equipment, as well as raw materials, operates under the handicap of prospective changes in requirements. Here is a real dilemma of the first order: to standardize or freeze designs and specifications in order to go into mass production or to make frequent, yet necessary and important improvements which slow down large scale production. On the one hand there will be large quantities of equipment, some of which may be obsolete, and on the other hand a small amount of equipment in which has been incorporated the latest developments and improvements. Desirable changes in requirements must be made from time to time as impelled by new designs, new weapons, foreign developments, the probable location and nature of the war. New inventions cannot be excluded for without them the depth bomb and the tank would not have been made available in the World War. Changes in requirements are inevitable, but they must be considered and evaluated with respect to their industrial implica-

tions and, when adopted, they must be reflected promptly in an orderly and comprehensive manner all along the line. Continuous changes in requirements preclude the establishment of a definite and complete procurement program. Furthermore, once industry has been [illegible] to a production program any major change will cause serious difficulties and delays in production.

The ability to make changes in production in time to meet the changed requirements will depend on close production control. The objective of production program control is to maintain a balanced production of requirements by anticipating, preventing or eliminating delays. This is one of the most important points at which statistical data serve an indispensable need. This system of statistics, which accurately presents the current status of production and requirements in a simple and readily understood form, is an essential tool of production control.

The operation of production control is based on frequent, periodic statistics supplied to the Statistics Branch of the Office of the Assistant Secretary of War by the Supply Arms and Services. These reports include data on progress of procurement and production, orders on hand, stocks available and current deliveries. The Statistics Branch is the central office in which all pertinent information is assembled and analyzed, and made available in a clear, concise report to those persons who are in positions of control and authority.

The contribution of statistical control to the success of the military aspects of the defense program lies in accurate and timely reporting of the progress of the production program. The function of the Statistics Branch is to select from the mass of data available to it the significant and essential information which will be needed by the persons in control. Military statistics are, therefore, administrative statistics [illegible] data required by those in authority to formulate policies and to make decisions which affect the progress of the National Defense effort.

PROBLEMS OF STATISTICAL CONTROL—ECONOMIC ASPECTS*

By Robert R. Nathan
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Problems of statistical control of the Defense Program from the viewpoint of economic aspects are difficult to cover even in outline form within the space permitted. The magnitude of the defense effort, even if considered only in terms of existing appropriations, is so tremendous that its impact will be felt in every area of the economy. Its aspects are as diffuse as the whole field of economics itself. Should the magnitude of the Program expand to what might be conceived as a "full defense" effort, its economic effects will become even more varied and far-reaching.

As now embodied in legislation and in British military orders, expenditures for defense will, a year or less hence, certainly *exceed* an annual rate of ten billion dollars. This represents considerably more than 10 per cent of our total national income. In terms of commodity needs it represents perhaps as much as one-fifth of our total finished commodity output. It is a tremendous effort and one which must be brought to a successful conclusion.

The statistics essential for policy-making purposes in the Defense Program are greatly different from those needed by private business enterprises in their internal operations. The size of the program is only one of the features distinguishing it from a large commercial undertaking. A corporation generally can make its decisions independent of its own impact on general business. It will determine its purchasing, production, and marketing policies on the basis of internal matters and in relation to the general business picture. Rarely need it base its own policy on consideration of just how that policy will influence the entire market and, in turn, influence the original policy-making. The Defense Program is different, in that the Government must recognize clearly the marked effects of its operations on the business community and determine policy with one eye always on the economic effects on the Program. It must give consideration to the many new problems which will be encountered in the attempt to give such an extensive program real momentum within a very short period of time.

Among the many important angles which must be considered, the first and the foremost is that of laying the groundwork intelligently and

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vigorously for getting a big job done effectively and rapidly. The element of speed, coupled with special difficulties of a technical nature, raises many complex economic problems, and unless these problems are anticipated well in advance and handled properly, the ensuing difficulties will be truly overwhelming. Data essential for decisions must be assembled and analyzed quickly since policy-making cannot wait on long-range research. Flexibility and speed must characterize the statistician's work.

Another factor is the need for producing the defense requirements as efficiently as possible and at the lowest cost consistent with the objective. Cost in terms of dollars or even in terms of labor and material resources may not be the principal criterion, but on the other hand wholly indiscriminate and aimless procurement operations can cause innumerable difficulties throughout the entire economy which, in turn, might bring delay and confusion.

This brings us to another important element; namely, the need to achieve the defense objective with the least possible disturbance to the balance of the economy. By setting up an objective of disturbing the economy as little as possible, we must not imply that the defense effort plays second fiddle in any area. There can be no room for doubt or indecision on that matter. First and most important is our need for rapid armament and nothing should stand in its way. On the other hand, there are many paths which can be followed. Not infrequently, the most effective methods are those consistent with the least disturbance to the non-military area—least disturbing in the sense of maintaining established institutions, price relationships, balance in productive facilities, meeting civilian demands, and retaining desired labor-industry relationships insofar as each is consistent with the defense objective itself.

Our problem here is really one of discussing what statistical information is essential for doing the best job possible. I can assure you that the data needed are not ready-made. Great strides have been made statistically during the past couple of decades but all of you know that when a specific job is to be done, confining oneself to existing source material imposes substantial limitations on the research worker. On the other hand, there are so many statistics available that we must be careful to avoid all duplication of effort. Our statistical efforts must be as efficient as our use of industrial equipment. It is not only a matter of efficient use of statistical energies in the policy-making group, but it is also a matter of placing as light a statistical load as possible on the military personnel and the industrial producers.

The most obvious needs relate to factual data on requirements and on our capacity to meet these requirements. Requirements include both the military and non-military demands of this Nation, as well as a number of foreign countries. Mr. Laug's paper tells you of the Army's statistical work. Similar steps are being taken in the Navy Department where A. H. Richardson has been installed recently with functions generally paralleling those of Colonel Leonard P. Ayres in the War Department. For British Empire countries the British Purchasing Commission is submitting data through the United States Treasury Department. The Bureau of Research and Statistics of the Defense Commission, under the direction of Dr. Stacy May, must assemble the military needs of the Army, the Navy, the Coast Guard, Great Britain and other countries and combine them into a simple realistic picture.

The development and assembly of military requirements is not an easy task since such requirements can and should be determined under a wide variety of assumptions. Simplest, is the matter of determining requirements on the basis of contracts which have been placed. Only slightly more difficult is the problem of determining requirements under total Congressional Appropriations and Authorizations. Beyond these rather clearly defined areas, there should be sets of requirements under military programs of varying magnitudes. For instance, should British requirements be taken only on the basis of orders placed? As raids on Britain continue and as our ability to supply materials to Britain grows, what magnitudes may British demands reach? How far may our own Army and Navy Program be expanded should the defense needs appear larger in the near future? These are very important and practical questions and there should be statistical data on requirements for all of these possibilities. No one knows what the future holds in store for us. Certainly the best insurance is complete preparedness.

One very important aspect of the requirements problem relates to the timing of needs. There should be a time schedule for as long a period in the future as is feasible and by as short time intervals as is practicable. Here, too, there are alternatives which at first glance do not present themselves. Again the simplest approach is that of timing requirements only after contracts have been placed. However, this shows only the schedules of deliveries month by month or quarter by quarter as promised by the manufacturers. In essence it is not a schedule of needs. On the other hand, requirements may be scheduled exclusively on the basis of needs and without regard to all of the restrictions which may render such a schedule impossible. Or, there may be a middle path, wherein the schedule may not be based exclusively on desired time ob-

jectives but rather on probable time objectives, that is, when the military branches think they may be able to obtain the equipment. Again the emphasis should be on the most ambitious goal possible.

Time objectives may vary with types of defense efforts. Some items might be pushed at the expense of others or even at the expense of expanding facilities if the timing objectives so dictate. If the effort is a matter of only weeks or months, decisions concerning expansion of productive facilities or the training of labor will be different from policies based on a defense effort which might call for feverish activity over a number of years. Proposals have been made for lengthening of hours of skilled workers in preference to widespread training. This might be preferable for a short emergency, but certainly both are needed if a long and extensive program is envisioned. We must be sure we shall have a post-war period to which we can adjust ourselves. Timing considerations are very important on the matter of aid to Britain. Ships take time to build. Should we withhold our combat and merchant ships or will the transfer of some of our ships to Britain give us more time to construct new ships here? These are not exactly statistical problems but data on various timing alternatives can be very helpful in arriving at intelligent conclusions.

I must not leave the matter of timing without stating what should be obvious but what nevertheless deserves emphasis; that is the need for coordinating and harmonizing different items into a balanced total. This is true not only of components of large items, but also of different items needed to complete the equipment of certain military units, and even of the needs of the Army in relation to the needs of the Navy, or our needs in relation to those of the British. You can't have men without equipment or housing. Therefore, the timing of mobilization must be coordinated with the timing of these needs. Similarly, guns are of little use without ammunition and planes without trained pilots are of limited value. Tanks and airplanes are not complete until every essential component is complete. Such coordination is obviously vital.

Finally, under military requirements, there is the difficult and extremely important job of translating military items into their semi-finished and raw material components. An airplane factory is of little use if aluminum and other essential raw materials are not available. Guns and explosives can't be fired unless there is zinc and copper for the cartridge cases. Estimating raw material needs is difficult because so many of the finished products are extremely complicated and because the peace-time production of many of these items has been either small or non-existent. The job of translation requires a considerable volume

of statistical data in the form of bills of materials, which must be obtained from the military branches or from the manufacturers themselves. One of the most bothersome problems encountered is that of taking into account the waste factor between the initial and final stage of production. Also, it is necessary to have data on the types, shapes, sizes, and the chemical or metallic content of the raw materials. Shortages appear more frequently for specific types or grades of a commodity than for the commodity as a whole.

Also, the components and raw materials must be scheduled by time, dependent upon the schedule of the finished products. For items which are characterized by short periods of production this is not so difficult. However, for battleships or heavy ordnance, it is not an easy task to determine the time leads in terms of weeks or months between the completion of the finished product and the various components and raw materials incorporated therein. This is both an engineering and a statistical task.

For comparing requirements with capacity data to locate possible shortages, it is necessary to determine civilian needs which can be combined with the military requirements. Civilian requirements may be determined under a number of assumptions. There are some individuals who believe that civilian requirements under a war effort should be computed at a minimum level, even as low as that at the bottom of the depression. Others would be more magnanimous and consider the average of the past three to five years, as a minimum basis for requirements. Still others would use previous peak levels. On the other hand, there are those who believe that the huge defense expenditures, which will increase the flow of funds into the hands of consumers, will in turn bring a markedly expanded consumer demand for goods and services and that estimates of this demand should be accepted as an indication of civilian requirements. This departs from the use of arbitrary criteria and estimates consumer demand on the assumption that no onerous restrictions will be placed on this demand. If the purpose of requirements and capacity studies is to reveal probable bottlenecks then certainly the civilian demand should be forecast on the assumption that there will be no shortages. These studies will then reveal the shortages and emphasize the policy question—expansion or priorities?

Considerable attention has been given to forecasts of national income in terms of current price levels, varying from 80 to 90 billion dollars within the next two years. This means enlarged consumer income and demand unless restricted through consumer taxes or other means. If

this demand is to be satisfied and a runaway price situation avoided, there must be a commensurate expansion in the output of consumer goods and services. Despite the huge defense outlays it is likely that we shall have a continued large volume of unemployment for some time to come, unless we encourage an increased output of consumer goods and services. Expansion necessary for this enlarged production will serve to permit a much larger defense effort a year or two years or more hence, when we may need for ourselves and for Britain much more than is now indicated by appropriations and contracts.

For the purpose of estimating future consumer requirements we are in need of estimates of national income in the next two or three years. Non-military requirements cannot very well be developed item by item since the demand for each commodity or service will depend on assumptions regarding other goods and services. It is more logical to estimate the likely total production and base the specific items on the total national income. For this purpose data are needed on factors influencing the national income, such as probable levels of private investment, export balances, inventory accumulations, consumer credit, Government net contribution, and other offsets to savings. In addition to forecasts of total income, it is essential to make some approximations concerning the nature of consumer demand and this requires some decision as to the probable effect of the defense program upon the size-distribution of income.

Now we come to a very important problem about which relatively little statistical information is available. That is the problem of capacity. A wide variety of proposals have been made for studies on capacity. Many of the criteria for capacity determinations which have been advanced do not appear practicable. Some of these have been extremely ambitious and would call for a nation-wide survey of the production and capacity of every industry which might possibly be utilized for defense purposes. Even those industries which fall most strictly within the consumer goods category would be surveyed in order to determine what types of equipment they possess, which could be used for sub-contracting of defense orders. At the other extreme, proposals have been made to rely almost exclusively on past levels as rough determinates of capacity. Obviously, statistics of the previous high levels of production based on the weekly or monthly peak output are very useful in providing some evidence of what specific industries can produce. Such figures are especially useful if there is also available any evidence of such qualifying factors as the amount of idle equipment during previous periods of high production, recent changes in the

quality and quantity of equipment, convertibility of plant and machinery, or if there is some empirical basis for gauging the possibility and results of multiple shift operations. Data are needed on labor skills required, on the availability of such workers, and the possibilities of training or substitution. The Bureau of Labor Statistics is engaged in estimating requirements for labor in different industries and occupations. The Employment Security Division of the Social Security Board has been collecting a considerable amount of information along this line from employers. The time and cost of industrial expansion and the obtaining of raw materials necessary for expansion must also be taken into account.

Perhaps statistics cannot answer all of these questions on capacity, but they certainly will help. We must not forget that decisions must be made and made promptly.

Above and beyond the whole area of requirements and capacity, there are a number of other questions relating to national defense which require a great deal of statistical material. Some of these take the form of economic problems and others of administrative problems. Among the former are such questions as the establishment of stockpiles, substitutibility of materials and men, price policies, government fiscal policies, and labor policies. Many of these problems require very precise and careful records. Decisions to provide for stockpiles of specific commodities must be based not only on requirements and capacity studies, but also on specific data concerning the commodity such as sources of supply, influence of the war on demand, elasticity of supply, tariff restrictions, effect of embargoes, time required to accumulate the reserve stock, and the storeability of the commodity. For establishing policy on substitution and on shifting material and labor resources, it is essential to have information on the resources of the various products under review, the residual effects of taking them away from certain areas, the implications in the new areas of application, and the post-war readjustments which will be necessary. For instance, any utilization of the automobile industry's equipment and man-power for airplane manufacture must concern itself with its impact on automobile production, the efficiency of such equipment in airplane production, the problem of seniority of employees should they move to new plants, tying in of the airplane and automobile companies for design and specification purposes and similar questions. Some of these can and certainly will be answered without the help of statisticians, but for most of them some background data will be essential.

Price policies, fiscal policies, and labor policies have been given much

consideration in recent years—particularly the latter two. Now, however, decisions on these matters must be more specific. They are much more pressing than heretofore in the sense that these policies must be related to the defense objective. In the case of fiscal policies, expenditures for defense will certainly be far in excess of recent government outlays. Taxes will be affected not only by the increased flow of income but also by new tax provisions already enacted or to be considered during the period of the Defense Program. Decisions on the magnitude and types of borrowing and taxing must take into consideration the probable effects of the defense expenditures on savings and upon consumers' income, as well as the effects of the financing scheme upon consumption, savings, private investment, and related matters. In the field of labor, wage rates in relation to prices and profits must be studied and coordinated with any policy concerning strikes. All of our statistical resources relating to wage rates and labor's share in the total income must be assembled and utilized intelligently in this situation.

The Defense Commission has already been called upon to consider priorities and the granting of certificates of necessity for new plant and equipment under the provisions for the short period of amortization. Statistical material in new and practical forms is essential for these functions. For instance, in determining whether or not to grant a particular manufacturer a priority rating for a specific raw material, a vast amount of information is necessary on other users of the particular commodity and the effect of shortages on their operation. Not only must the consumer of an item in its first stage of production be considered, but consumption must be traced to finished products. Should a question arise concerning priorities in the case of steel, it will be necessary to know not only the types of steel which are made, but also the uses of each type through a number of stages of production. In deciding priority matters for machinery, alternative resources must be considered. The granting of priorities must be selective or there will be an endless pressure for successively higher ratings.

In the matter of certificates of necessity, alternative possibilities to the new capacity must be taken into account. On the one hand, every effort is being made to induce industrial expansion. On the other hand, for certificates of necessity it is essential that the expansion for which a certificate is requested, be shown as necessary. For instance, a new foundry needed by a manufacturer for defense orders may not be necessary if other foundries are available within usable areas. You can well understand the need for statistical surveys and for cooperation from local sources of data for this purpose.

No doubt this mere listing of types of data needed leaves one with some confusion and uncertainty as to just how the job is to be done and where the figures are to be obtained. Some of the work has been done, but there is still much to do. Corners will have to be rounded and related statistics used where direct data cannot be had. A stockpile of statistics must be accumulated, because requests come fast and answers must be prompt if the data are to be useful. Some of the requests calling for answers within 24 or 48 hours are truly alarming, but we must do the best that can be done within the time limit specified. Policy making cannot long wait for research. This is not going to be the statisticians' millennium, and we must confine the gathering of new data to fields and areas of absolute necessity. There have been many instances where all kinds of new and old statistical projects have been brought to the fore on the basis of being related to the defense effort. Suggestions and aid are most welcome but we must not place anything and everything under the banner of "National Defense" and take on any and all proposed studies. On the other hand, we must use imagination and foresight, seasoned with a strong realistic perspective.

BUSINESS APPROACHES TO REARMAMENT PRODUCTION CONTROL*

By Theodore H. Brown
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According to a recent address made by Mr. Knudsen before a meeting of the National Association of Manufacturers in New York, progress in rearmament has been far from satisfactory. The appointment last week of a four-member commission to direct the work is evidence that the program has lacked both direction and coordination. The impetus which has been added is good, but, as Mr. Knudsen has implied, there is still much to be done. Everyone realizes that the mere size of the national defense program introduces new elements which present serious difficulties. Among the problems is the task of welding into a single unified system the productive capacities which are widely scattered throughout the country. In the process of coordinating production, the managerial impulse is to get results by an increase in the centralization of production facilities. The trend, however, is toward decentralization both because of reasons of national safety which offset certain dangers in case of actual war, and because of the changes taking place in our political, economic, and social system in which concentration of power is swiftly moving in the direction of political dictatorship control.

In the problem of effective production, for which the general objective is obvious and for which the solution is largely unknown, the desired methods of procedure might be discovered through original research. But time is short. Every available short cut must be used. It would seem that one sensible thing to do in order to save time and effort would be to review the experience of business. Such a review should be undertaken with the thought of finding out what has been accomplished and with the hope of discovering information which would be useful in a control plan for production on a national scale. The complete picture cannot be found in any one company because businessmen have so far developed only the initial stages. Consequently, in the material which follows an attempt is made to summarize certain known experience which is related to the national problem. One must always bear in mind, however, that this rapidly expanding phase of management not only is incomplete but is very likely to change from day to day.

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A review of business experience shows that the development of controls is taking place along certain definite lines. First, controls are needed in research work. In this category will be found certain diagnostic controls which are of extreme value in guiding new engineering developments as well as in directing market research. Because we are concerned with continuing production controls for rearmament these diagnostic controls are outside of the limits of the present paper. Likewise the problems of fixed and flexible budgets and budgetary controls are passed by, since these directly concern the individual company and only indirectly affect the national problem through costs.

Continuing controls for the production phase of company management are of two types: namely, the control of quality of the product manufactured, and the control of the quantity to be manufactured. The ideas present may be summarized briefly. In the first place, the result of quality control often is equivalent to a control of the manufacturing process which is involved in producing a particular article. If a reasonable number of finished pieces do not meet inspection tests, it may be that the manufacturing process is not under control. For example, in one plant the irregularities in the number of pieces rejected by the inspection department led to a change in the manufacturing process which resulted in a much greater uniformity of the finished work. Quality control in this case reached back of the work of the inspection department into the character of the manufacturing process. In the second place, the volume or quantity control is important in relation to company policies and plans. In business these in turn are dependent upon the marketing policies and plans. In the case of the Nation they depend upon the plans for M-day. For example, a company's volume of production during a given accounting period should be dependent upon a balance between the estimates of sales for that period and the size of inventories. There are many problems here either in the work of estimating sales or in the control of inventory. The devices used range all the way from simple record keeping to analyses based upon theories of advanced mathematics. Finally, it is clear that quantity control involves not only the volume produced but also the element of timing, because in a factory assembly line, if the parts are not available, the assembly process stops.

The general comments so far made are not sufficiently definite to provide a clear-cut line of attack. Lack of space prevents a review of the experience which leads to the belief that control devices for company management differ in character from both accounting and statistics. Some conclusions, however, may be stated. Controls often

require the use of accounting principles and procedures, but they do not exactly parallel either the rituals of accounting or the practices of cost accounting such as those found in some developments of flexible budgets. Controls make use of statistical procedures, but frequently these procedures do not follow standard teaching such as in the case of estimates of future sales. On the basis of these beliefs, however, certain concepts stand out as being important. Because these concepts clear the way for an understanding of the controls which business requires, they will be discussed first.

Basic Concepts and Principles. The fundamental concept in both statistics and accounting is that of classification. The idea is extremely simple, consisting solely of the assumption that numerical information can be sorted out in accordance with definite, prescribed criteria. In fact the science of statistics assumes as basic the process of classification undertaken as a foundation for induction. Possibly the very simplicity of this foundation creates a willingness to accept the process of classification tacitly and then to forget its importance. Probably because students also understand it, earnest teachers tend to avoid it because it leads to perfect scores in examinations.

In business the word "table" is used as a substitute for the more technical term "classification." Tables can be set up to present data in accordance with one or more criteria of classification. In a single table consisting of columns and rows, the analysis is limited to two criteria. Nevertheless, the device is a powerful tool because individual cells located at the crossroads of the columns and rows within the table can be discovered by the intersection of a selected column and a selected row. The device is widely used in business. For example, in a certain chain of stores the control reports classified sales in two ways. The information was sorted first according to stores without regard to departments within those stores; second, by departments regardless of the stores. Applied to the two-way table the data for the stores were the totals of the columns, and the data for the sales of departments were the totals for the rows. If for a simplified example the record for a store was bad, a column was identified. If the total for a particular department was out of line, a row was indicated. The cross of these two roads then would indicate a particular department in a particular store.

The classification or sorting concept appears in a slightly different guise in production control. The consumer thinks of completed machines or products. The manufacturer, however, for production control must think in terms of parts. The job then is to sort out or to classify the component parts of various models of completed products according to

individual parts. This process of sorting is known as production explosion. The idea present is that of exploding the completed machine into its detailed parts. The use of this term assumes that the explosion also includes in the process a systematic classification. For example, if 1,000 automobiles of each of two models, A and B, are to be built differing only in the type of body and in the length of frame, then there would be 2,000 motors, 2,000 sets of wheels, 2,000 steering gear assemblies and so on, but 1,000 frames of Model A, 1,000 frames of Model B, 1,000 bodies of Model A, and a similar number of bodies of Model B. Each of the assemblies in turn are to be exploded. In the case of the motors, if they were designed with eight cylinders, each with two valves, there would be 2,000 cylinder blocks, 32,000 valves, 32,000 valve springs, and so on. The fundamental idea here is that a finished product often consists of standard assemblies, subassemblies, and parts. The production explosion process shows how many units in each class of standard parts are needed to make a given volume of the final product.

A second concept which is also of first rank in importance in control work is that of timing. Finished parts must arrive at the assembly line in just the right quantities and at the proper times in order to prevent a bottleneck in the work of assembly. Carloads of lumber arriving at the site of a future army camp are useless if the material for the foundation has not yet appeared or if nails and other hardware are not available. Many illustrations will come to mind of this important element of timing. The time element enters into another measure, slightly different in character, that is, the concept of turnover. Turnover measures the volume of material going through a process during a given period of time in comparison with the volume on hand at some standard time. It represents, therefore, a time rate of flow, or, in relation to a standard unit of time, the velocity of flow. This measure as a control is effective if properly used, but frequently is ineffective because it is badly applied.

A third somewhat more complicated basic principle is the concept of a standard. We human beings know practically nothing in the abstract. We appraise a particular situation only in comparison with other experience. Recognizing that experience is not always uniform, we condense it into a single thought or figure which represents an average. The concept of a standard is common in cost accounting. Businessmen are familiar with this and accept it readily. Moreover, they understand that a standard cost represents a figure which is extremely useful when they desire to interpret the meaning of an actual cost. The curious part about the situation is that, when a similar problem is attacked through

the use of figures which are labelled statistics, the businessman adopts a stupid attitude when he expects a precision which is impossible. Thus, in a so-called forecast of sales, which would be far more wisely termed "estimate" of future sales, there is only set up a standard expectation. Departure from such a standard is extremely probable, but the businessman seems to think that the statistician can produce estimates of the future with a precision accurate to 1/10 of 1 per cent.

The departures from standard are important. One expects sevens on a pair of dice about once in six rolls of the "bones." If sevens exceed this standard number by a sufficient amount known with or without the help of higher mathematics, one can begin to suspect that an undesirable control is being exercised. It may be said that the dice probably have a market bias. Whether the market bias is in the equipment or in the managerial control need not concern us for the present. We need only to remember that shooting begins when certain limits are passed. The concept of control consequently states that there may be drawn on either side of the standard certain limits within which the element of human variation has full play. When the observed conditions pass beyond these control limits, unwanted artificial conditions are beginning to impinge upon the situation. The red flag of danger is thereby waved to indicate that the situation is out of control.

Quality Control. The pioneer in quality control work is Dr. W. A. Shewhart of the Bell Laboratories. A somewhat over-simplified, illustrative statement of the procedure for quality control may be made as follows: If there is recorded lot by lot the percentage of defective pieces as determined by the inspection department and if these have been manufactured under good operating conditions there can be determined not only the average or standard percentage defective, but the control limits within which 99 per cent of future good experience should be expected. The data of this trial run set the controls. Subsequently the pieces produced lot by lot are handled in such a way that their histories can be identified throughout the manufacturing process. As each lot passes through the inspection department the percentage defective is recorded against the standard and control limits already determined. As long as these percentages come within the control limits, nothing is done. As soon as the per cent defective for a particular lot gets beyond the control limits, the danger flag is up. Because the lot is identifiable, careful search for the causes of the excessively large waste then follows. When the cause is determined the condition which gave rise to it is corrected and the process is repeated. The result in practice has been to reduce by this procedure of cut and try the standard per cent of

wastage, and to narrow the control limits at the same time. The success of the plan depends upon the identifiable lots. Moreover, production warns research, and research aids production; the two are joined. There is, of course, a reasonable point beyond which the cost of improving quality is greater than the benefits to be derived. At this point it is no longer desirable to change standards of wastage or to narrow control limits. Subsequent experience then becomes one of controlling production in relation to these known standards.

The consequence of this for production control is a change in the idea of the function of the inspection department. Originally the purpose of such a department was solely to reject those finished articles which did not meet the manufacturing specifications set as engineering standards. The Shewhart concept introduces for the guidance of the inspection department a set of specifications for quality controls which are based on statistical theories. These are different in character from manufacturing specifications. By their use the inspection department no longer remains merely a rejection point but becomes a control agency.

In summarizing the idea certain elements have necessarily been neglected. For example, in a consumer's good like an automobile there are additional complex qualities present. The quality of one part is brought into relationship with the quality of another, as in the case of an automobile axle and bearing. In addition to these more or less complicated conditions there is the final quality which makes a good wantable. Regardless of these complications, interest at the moment centers about the implications of the plan in connection with government contracts and government inspectors. The question may be raised whether certain difficulties might not be cleared away if there were employed by government officials some of the ideas in this system of quality control as now practiced by a handful of manufacturers.

Quantity Control. The keys to the control of quantity for goods like machines are to be found in the number or volume of the basic pieces to be produced and in timing those pieces to reach the assembly line when needed. Attention in this problem consequently must be directed towards the basic unit pieces, rather than completed products. The control plans, however, must start with the completed product.

The quantities of a given product which are to be produced are dependent upon plans. Commencing with the number of units of each model which are to be distributed or sold these plans include also the productive capacity of a given plant and the condition of its equipment. The making of plans inevitably involves estimates of the future. If the

full capacity of the plant is to be utilized, then the plan essentially depends upon plant capacities at various times. If, however, the manufacturer is marketing his goods wherever he can, his estimates will involve an appraisal of his buying public. These problems essentially are statistical estimates and are subject to all of the difficulties and hazards that are involved in making such estimates. Inevitably they will include also an appraisal of the risk of strikes or other delays caused by labor. There are many ways of making attacks upon these problems. Many of them have appeared in public print so that there is no need of describing details here.

After plans have been made, the control of production starts with the number of units of each model prescribed in the plan. Production explosion is applied so that by classifying the number of assemblies, subassemblies, and/or parts, the total number of elementary pieces can be determined. It is not necessary to carry the production explosion process as far as the individual pieces in all cases since the manufacturer may buy certain assembles or subassemblies already completed. The problem now is that of planning the production for these elementary units so that they will be on hand at the assembly line at the proper time. Thus production explosion leads to timing. Every manufacturer will recognize at once that in this plan there are many other problems. For example, requirements must be balanced against inventories. The system must recognize some way of stopping foremen from taking over parts which are needed in the assemblies to be produced later. There is the question of the machine load and a careful time of delivery check on vendors if parts of the finished, semi-finished, or raw materials are to be purchased outside. Their quality also must be checked possibly by one of the methods already suggested. Moreover, the statement assumes that the quantities of raw and semi-finished materials have been appraised so that supplies are available. This requires coordination in another direction. The problem is not simple, but extremely complex, especially if there are literally tens of thousands of different parts entering into the final product. The details need not concern us here. It is sufficient to say that apparently the problem is being solved and that it is dependent upon the concept of production explosion, proper timing, and a balance of expected production in relation to inventory.

Again the review of business cases makes clear the fact that this system which is being developed for quantity production control is not the only one. The reason appears to be present in the additional factor of the character of the goods. If the individual product is relatively

simple in the sense that it is not an assembly of many pieces, the job can be much simplified. In fact one company apparently has solved the problem by adopting control limits for the stock of finished material which is balanced between production and inventory. In the case of a continuous process where the operation of the productive machinery must be as nearly continuous as possible, still a different type of control has been used which makes the control a function of the continuity of the operation of the machines. Goods falling in this category include textiles, paper, certain plastics, and other similar articles. Finally, in inventory problems it has been found true that in some cases the use of a turn-over figure is of help. Here the basic idea is that of a turn-over figure which measures the velocity of goods flowing through the inventory for each homogeneous sub-part of that inventory. The measure has been applied so frequently to situations representing a miscellaneous class of goods that it must be mentioned in passing as a valueless if not dangerous practice.

Administration Report. All that has been said depends upon the administration factor for success. Executive experience must be aided by properly organized technical reports. As judged by many cases the reports intended for executives frequently do not put into their hands information so organized that it is an aid in meeting the responsibilities which they have to face. The days of the pompous big man are passing, at least in business. Fortunately it is only on rare occasions that one meets an executive holding a very responsible position of whom it might be said that he was so important that even the stop lights turned green at his approach. Executive reports, even those which are statistical in character, are not all of the same type. First, there is a decided distinction between diagnostic reports and those which are to maintain a given condition within a business and which have been termed continuing controls. In this paper it is the continuing control type which has been kept in mind. For the purposes of production control, there are certain important elements which bear upon the situation. First, there is the question of flexibility. Priorities have and will continue to have an important influence upon the situation. The reports must be able to reflect the shifting importance of materials depending upon these priorities. Next, in a program which is national in its scope, there must be a whole series graduated in detail. It is senseless to attempt to place before top-side executives the mass of detail for which a subordinate must be held responsible. On the other hand, the reports should so summarize for the top executives the data which bear upon the situation that he can immediately locate areas within which there

is trouble. The detail reports in the hands of subordinates should provide the information which will identify bottlenecks and choke points.

The problem of production control on a national scale is a new and a serious one requiring research skill for its solution. The first step is to discover what others have done. Business represents the best prospecting ground. The experience of business indicates that there are certain basic concepts which have been proved to be successful in the work of company production control. For the national problem the most important factor is coordination with the power of decision placed in the hands of one administrator. This has not yet been done. The fault lies squarely on the shoulders of the Chief Executive. Without authority there can be no coordination. Without coordination business knows only too well that there can be no effective plan. Without a plan there will be no adequate control of a rational business character.

HOUSING IN RELATION TO NATIONAL DEFENSE*

By Samuel J. Dennis

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The experience of the last war demonstrated very clearly the place which housing occupies in a defense program. At that time, enormously expanded production and employment in defense industries led to correspondingly large movements of population into the centers of defense activity. And, in a great number of cases, the housing supply did not, or perhaps could not, expand in equal measure. This lack of housing in key industrial centers was quickly followed by inability to secure the labor needed for defense production, because workers were unable to find satisfactory living quarters for their families. Even where it was possible to attract the necessary employees, they quickly became dissatisfied, and labor turnover was excessive. Productive efficiency suffered, and standards of living were lowered. Remedial measures were eventually undertaken, but they were started much too late.

In the present emergency, a determination has been evident from the very start to deal with problems of defense housing more intelligently and more promptly than we did twenty years ago. This determination is a very natural consequence both of our World War experience and of the increasing attention given to housing during the past decade. Establishment and growth of a number of Federal agencies concerned with housing have made it easier to understand and foresee the problem, and these new agencies have supplied a volume of experience in dealing with housing questions which has greatly facilitated execution of a defense housing program.

At the outset, it should be made clear that the following discussion relates primarily to housing for civilian workers in private and government-operated defense industries, for civilian employees of the Army and the Navy, and for married non-commissioned officers. I am not speaking of barracks or cantonments, or of housing for officers.

Our present problem is to assure that housing is available to men and women engaged in defense activities in sufficient volume that defense work can be carried on at a high level of productive efficiency and without undue labor turnover. At the same time, in so far as possible, we wish to preserve living standards and to assure a reasonable level of rents and other housing costs. All of these objectives imply the necessity for an adequate housing supply.

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 28, 1940.

The most important source of supply of housing for these defense purposes is found in the existing stock of houses. By this I do not mean merely the existing supply of vacant houses, though they are important in the picture. I mean houses in which people are already living. This is not as paradoxical as it seems. At the present time, at least, a very large proportion of the labor for our expanding armament industries is drawn, directly or indirectly, from unemployed and partially employed persons resident within commuting distance of the defense plants. These people are already housed. The extent to which defense housing is provided in this way cannot be described at this time in any complete statistical picture, though it is possible to cite an example, which may be extreme but which suggests very forcefully the accuracy of this observation. I am thinking of one small town of about six or seven thousand people where a new munitions plant is being constructed. A survey has shown that there are practically no vacant houses in the town or in the surrounding country. Yet new housing will be necessary for perhaps only 1,000 of the 4,500 people to be employed at the plant. The other 3,500 will come from the unemployed, the underemployed, and the low-income farmers of the town and the surrounding country. Most of the employees will simply continue to live where they are now living, but will go to work at the new plant instead of sitting idle around home, or keeping house, or working at some intermittent or unremunerative occupation.

The rôle which vacant dwelling units can play in helping to meet the demand for defense housing may, in some cities, be of great importance; in others, where the vacancy ratio is low or where the absolute number of vacancies is small, vacant units may be of little consequence. For the country as a whole, the Census has reported a preliminary total of 2,400,000 units classified as "vacant" as of April 1 of this year. Because these first figures include some units not actually entering the residential market, perhaps less than three-quarters of this nunber were vacant for rent or for sale at that date, and some of these are summer cottages not fit for year-round occupancy. Since April 1, furthermore, some absorption of vacancies has probably taken place. Even so, the remaining number of vacant units is substantial and would go far towards meeting the defense housing needs if they were located where needed. But, unfortunately, existing vacancies are too widely dispersed to be of more than partial assistance; and in the industrial areas where they are most needed, the supply of vacant units is, on the whole, relatively the smallest.

On the other hand, new residential construction is not quite so per-

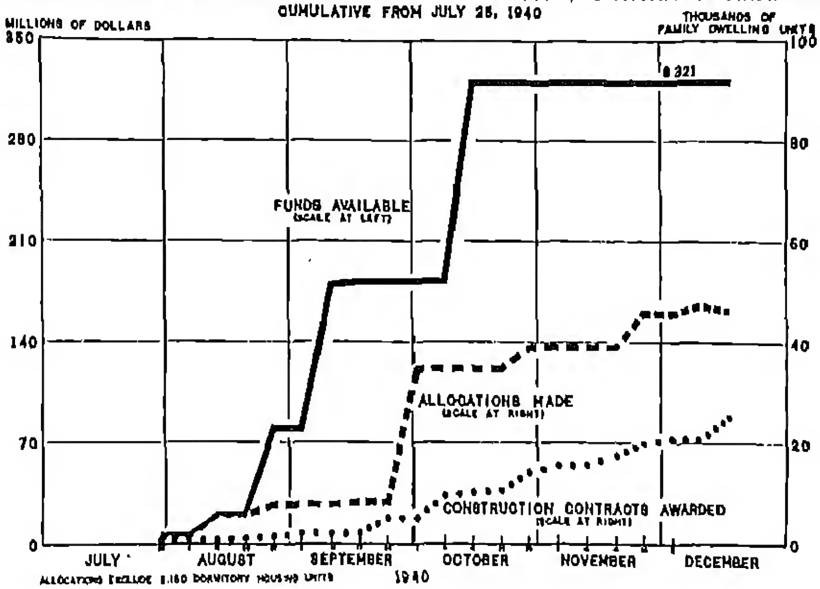
verse, and is in many cases active in the same localities in which the demands of defense industry are exerting the greatest pressure. The most prominent instance is perhaps that of the Los Angeles area, where employment in airplane manufacturing, shipbuilding and miscellaneous defense industries is increasing very rapidly. Currently, new residential construction in that area is running at the rate of nearly 45,000 units a year. A very large part of this current construction is serving to provide houses for workers engaged in defense activities. Similarly for the country, as a whole, a substantial proportion of current new construction is very clearly defense housing. In recent months, for example, the operations of the Federal Housing Administration have increased most markedly in the major industrial areas, where factory activity has been stepped up by the defense program. Again, it is not possible to guess exactly how much of this new construction will provide housing for defense workers. However, it is estimated by the Bureau of Labor Statistics that a total of 545,000 new units have been started in the non-farm areas of the United States this year, of which nearly 470,000 units have been built by private enterprise. If no more than a fifth of these are serving defense needs, private construction will be contributing as much to defense housing as the public program so far authorized.

Despite the activity of private building, new private construction and existing houses are not adequate by themselves to meet all the needs of defense workers. Housing for the families of non-commissioned officers in the Army and the Navy is needed on, or convenient to, military reservations, at rents so low (ranging mainly from 11 to 20 dollars a month) that private construction cannot profitably provide adequate accommodations. In the second place, the expansion that is occurring in many cities is very likely to prove temporary, to be followed by industrial decline and population loss after the emergency is over. In these cases, private construction can proceed only within limits, if at all. The housing that will eventually be surplus must be provided by the Government. Finally, in a few places, although construction by private enterprise appears justified, local capital and initiative have been absent.

Where one or more of these conditions exists, so that action by the Federal Government is indicated, it is possible for a number of Federal agencies to undertake actual construction. To assist these agencies in conducting their individual activities along lines that will form a single, consistent program, the Division of Defense Housing Coordination has been established. The primary purpose of that office is to determine

what the requirements are for defense housing and to see that appropriate steps are taken to meet them. Specifically, reports are received from the Army, the Navy, defense industries, and local officials concerning existing or prospective housing shortages arising from the defense program. For localities where there is evidence of a possible housing need, we examine the situation to see whether any new housing is necessary or whether the existing labor supply together with existing housing can meet the need. If it appears that additional construction

DEFENSE HOUSING PROGRAM
PUBLIC FUNDS AVAILABLE, ALLOCATIONS MADE, AND CONTRACTS AWARDED
CUMULATIVE FROM JULY 25, 1940



is essential, it is the responsibility of the Defense Housing Coordinator to make arrangements for the provision of that housing. In some cases, as we have already seen, the needs for additional housing can be met entirely by private construction. In others, where public construction is required, the Defense Housing Coordinator makes recommendations concerning the size and nature of the program. On approval by the President, actual construction becomes the responsibility of one of the agencies operating in this field, including the Federal Works Agency, the Navy, the Army, or the Defense Homes Corporation, a subsidiary of the Reconstruction Finance Corporation. In some instances, the Federal Works Agency has selected a local housing authority as its construction agent. Funds for these purposes have been provided by

direct Federal appropriations and contract authorizations which make available the sum of $240,000,000. In addition, an allotment of $10,000-000 has been made to the Defense Homes Corporation, which will utilize these funds in conjunction with $40,000,000 derived from the proceeds of mortgages insured by the Federal Housing Administration. Finally, the United States Housing Authority has set aside $31,000,000 of its funds for loans to local authorities, or in a few cases to the Army and the Navy, for defense housing projects. A total of $321,000,000 is thus available for public construction to meet defense housing needs. The chart presents a record of the time at which these funds became available, together with summaries of the dwellings for which funds have been specifically allocated and those for which construction contracts have been awarded.

Through the 18th of December, allocations of funds had been made covering 46,405 family dwelling units. Funds had also been set aside for 2,150 units for single men. Of the 46,000 dwelling units, about 17,000 are to be built by the Navy, 17,000 by the Federal Works Agency (including the Public Buildings Administration), 1,000 by the Army, 1,400 by the Defense Homes Corporation and nearly 10,000 by local housing authorities. As of December 18, furthermore, the number of units for which construction contracts have been awarded amounted to 25,101. Most of those, of course, had gone under construction by that date.

The dwelling units for which funds have been allocated, which total about 46,000 are intended for occupancy by civilian employees of privately-operated defense industries, and of the Army and the Navy, and by families of non-commissioned officers. Over one-fifth, or about 9,000, will be occupied by employees of private industry; another 9,000 by civilian employees of Government-operated industrial plants (such as Navy Yards and Arsenals); and the remaining 27,000 by other civilian and enlisted personnel. As the program develops further, these ratios will change considerably, and a larger proportion will be allocated to civilian employees in private industry. The Army and Navy needs were reported more quickly than those of private industry, were generally easier to verify, and in many cases became critical much earlier.

At this point, I should like to turn from consideration of the program as a whole to a discussion of the major statistical problem which it has so far presented. The determination of defense housing needs in any locality, on which the program necessarily depends, is obviously no simple matter, especially since the pressure for speed does not permit

as thorough a study as might be desirable. We are still in process of evolving a finished and satisfactory statistical technique for dealing with this problem. But we have made enough of a start so that the outlines of our eventual method are becoming somewhat clearer. As mentioned earlier, reports of housing shortages are received from many sources. Also, by following plans for new plants and for major plant expansions, we are able to locate many areas in which defense housing needs may arise. Tabulations of defense contracts are also useful in this connection. We have been comparing the value of these contracts with the value of the output of manufacturing industries in the same locality and, though the comparison is not precise, we are trying to examine all places in which the value of defense contracts is more than 25 per cent of the value of manufactures in 1937.

In some of these places, a preliminary examination is enough to show that a housing shortage is unlikely, and these are dropped from further consideration at the present time. For most of the cities, however, a final determination is not possible by this device. Through these sources, therefore, we are provided with a long list of cities where further study is desirable.

In the case of industrial cities, the next step is a study by the Bureau of Employment Security of the Social Security Board of prospective labor requirements and labor supply. A field agent is dispatched to the city, who secures from the larger defense employers, and from other principal employers in the area, the best possible estimates of the changes in employment that are likely to take place during the next year or more. Through studying the lists of the local employment office and estimating the proportion of the local labor supply which is registered, a forecast is made of the extent to which the employment requirements can be met locally. In this process, particular attention is paid to the possibilities of training local people to provide skills which are not present in the local labor supply.

In addition to securing estimates of the prospective changes in employment and of the source of the additional employees, the Bureau of Employment Security field agent makes an attempt to determine the proportion of single persons in the increased labor force. Such a measurement is necessary if we are to interpret the increase in the number of employees in the community in terms of additional dwelling units required. In addition, the field agent tries to get some idea of the weekly earnings which the new employees may expect, so that we in turn may know at what rent levels or sales prices new housing should be provided if it is to meet the needs of the defense workers.

The report of labor requirements and labor supply provides as good an answer as we have been able to get to the question of the demand for housing which the defense program will cause in a particular city. In order to measure the supply, two additional things must be done. A study of existing vacancies must be made, and this is done for us by the Work Projects Administration. A canvass is made by a mobile force of field agents who locate vacant dwelling units by inspection and then inquire at each such vacant unit concerning its rent and the facilities provided. Instructions are given to the enumerator to make special inquiry at large old houses which look as if they may have been converted and at other places where it may be difficult to determine from exterior inspection whether there is a vacant unit in the structure. In small cities, a complete canvass is made. In the larger places, a sampling technique is employed. In this way we get a count of the number of houses which are vacant and available for use, with an indication as to the proportion of these units which are of such poor quality that they ought not to be counted in the supply, and a further indication of the proportion which are so high in rent that they are beyond the ordinary capacity of the defense worker to pay.

The third part of our initial study of defense housing needs consists of a survey whose primary purpose is to determine how far the private construction industry can be counted on to provide new housing in which defense workers may live. A substantial body of information about housing conditions in general is also collected. Studies of this kind have been made for us by the Federal Housing Administration, and we are counting on the Federal Home Loan Bank Board to assist us in additional cities. As in the other studies, a field agent visits the community, to get first-hand information as to the current volume of residential construction and its characteristics. He also considers the recent rate of provision of dwelling units through alteration and conversion of older properties, and inquires into the attitude of private builders in the locality in the light of the defense emergency to see what their operations are likely to be in the next few months. The general economic background of the community is also studied, to provide some indication of the probable situation after the defense program is over.

With these three parts of the study in hand, it ought to be a matter of simple arithmetic to determine how much new construction is necessary in any case, and how much of it needs to be provided with public funds. But, unfortunately, our major variables are subject to substan-

tial errors and a good deal of judgment must enter into the final determination of the proper defense housing program.

Once this initial study has been made and our first program has been prepared, we have the further problem of maintaining a continuous scrutiny of the situation in each locality to determine whether revisions in the program are needed. For this purpose, various existing current series are being extended and new measures established. The studies of rents made by the Bureau of Labor Statistics as part of their general surveys of the cost of living have been expanded to cover additional cities. Data on new residential construction are being examined from month to month, and some expansion of these data would be helpful. We will also have to watch the changes that take place in employment.

The major task along the lines of current measurement which we have undertaken directly has been the establishment of agencies for the listing and counting of vacancies. For this purpose, a Division of Homes Registration has been established in the Division of Defense Housing Coordination. The vacancy registration bureaus to be set up by local defense councils with the advice of the Homes Registration Division have as their primary purpose the task of locating vacant units and providing lists of vacancies to defense workers who are looking for places to live. These bureaus will also keep for each community in which they are established a current record of the number of vacant rooms and family dwelling units available, together with a record of the number of applicants for accommodations. With these data, together with those mentioned above, we should be able to follow with at least some degree of intelligence the current changes in the housing situation.

The use of these current measures is as yet not nearly so well developed as the initial studies necessary prior to the development of a first program. It is probable, therefore, that their pattern will change considerably as we actually put them into operation.

The foregoing discussion has emphasized several phases of our work, perhaps to the exclusion of other phases of at least equal importance. Nothing has been said about the efforts which are being made to use demountable houses in places where defense housing will have no permanent use whatsoever after the emergency is over. By constructing houses which can be economically taken down and moved to other locations, it is hoped to prevent a serious burden upon existing real property in those areas. Likewise, I have not discussed the program of central purchasing which has been instituted in buying many of the

materials necessary in this program. By this, it will be possible both to operate at lower costs and to spread properly the burden upon material suppliers. Also, I have given entirely inadequate treatment to the analytical problem involved in analyzing the statistical material which comes to us, together with the various other items of information received from other sources. We have the problem, not only of determining how much defense housing is necessary, but also what part of it private enterprise can provide. There is, however, one aspect which certainly should be emphasized, that is, the importance of statistical information in the formulation of these programs. In this process, statistical information is used more directly as a basis for action than perhaps in any other governmental function with which I am acquainted.

ON THE INTERPRETATION OF CENSUSES AS SAMPLES

By W. Edwards Deming and Frederick F. Stephan
Bureau of the Census

For inventory purposes *an enquiry must be complete.* Both by historical precedence and by law, one of the primary functions of the census is to provide a count or inventory of the population as it actually existed on a specified census date (April 1st for the censuses of 1930 and 1940). Certain actions, involving the apportionment of taxes and Congressional representation, are based on the census figures, purely as an inventory as of a certain date. States and cities likewise utilize the census returns for reapportionment of the state legislatures and the city councils, for revising election districts, and for many other administrative purposes. These inventory functions are limited by the fact that the census information concerning individuals is held confidential; consequently, states and cities often maintain other lists for inventory purposes, examples being tax rolls, city directories, the registration for selective service, and social security registration.

For such purposes, the census must by definition, be complete. It differs not only quantitatively but qualitatively from any sample less than 100 per cent that might be taken. This distinction is independent of any defects that may occur in carrying out either the census or the sample.

As a basis for scientific generalizations and decisions for action, a census is only a sample. In addition to serving the function of an inventory as of a certain date, the census tabulations serve also another important objective, namely, as bases for prediction. Any social or economic generalization, and any recommendation for a course of action, involves a prediction. For such purposes, the census takes on the character of a sample.

Any census gives data of the past, but the generalizations and courses of action that are based on it concern the population as it will exist at some time in the future. A census describes a population that is subject to the variations of chance, because it is only one of the many possible populations that might have resulted from the same underlying system of social and economic causes.

The births, deaths, vocations, migrations, and educational attainments of a population are changed and directed by a myriad of chance causes, superimposed on certain underlying social and economic cause systems. A census shows what resulted from this combination at a certain time in the past, but any generalizations that are not restricted to

a particular date and place must recognize the fact that some other population might have resulted, and must in fact be expected to arise in the future from the same underlying causes. Because of these statistical fluctuations, it follows that as a basis for scientific generalizations and decisions for action, the distinction between complete and sample coverages is often only a matter of degree.

Then, too, the state of a population today depends not only on the actions of chance today, but also on the actions of chance in the past. In other words, the population of any area today depends partly if not largely on that population as it existed a year ago, or two years ago, etc. A common technical expression is to say that there exists a serial correlation between the states of a population on two different dates. It follows that for predicting the state of a population next year, the census of that population as it actually existed on the last census date is more useful than a census of this same population as it might have existed by possible different actions of chance. Fortunately, the only census that we can take is the one that is the most useful. Moreover, because of serial correlation, it is desirable that the census or sample of the population on the census date be as precise as possible.[1]

These ideas are not new. The sense of them permeates a considerable amount of statistical work and writing, yet they are far from being well recognized, and there is a dearth of explicit statements of them. Because of their extreme importance it seems worth while to put them into print, even if it has been done before.

The two excerpts given below are quoted for the clarity with which they summarize the arguments of this section.

> A so-called 100 per cent sample from the viewpoint of scientific method is, as soon as taken, a sample of the past. The usefulness of such a sample is only as a basis for drawing an inference about the future and in this case the sample (even a 100 per cent sample) is but a finite sample of a potentially infinite one that might result from the cause system existing at the time the sample was taken.[2]

> In all scientific investigations the object is to find, not the situation that prevails at a particular moment, but the underlying tendencies and relations which, with chance modifications determine these situations approximately. The chief object in sampling the population of Seattle is to find out something about the underlying relations that make that popula-

[1] In substance, this paragraph was expressed by Dr. Leon E. Truesdell in a conversation with the authors.

[2] Extracted from a letter written by Walter A. Shewhart to W. Edwards Deming, dated 9 May 1940.

tion what it is. The situation in the city fluctuates continually, and what is found today will not be exactly true tomorrow.[3]

Comparative advantages of a census and other kinds of samples in scientific investigations. When a given sum of money is to be expended on a scientific study of some subject, the object is invariably to arrive at generalizations and conclusions on which to base predictions. A well designed sample will then elicit the greatest possible amount of information; in fact, for such purposes there is no procedure of enquiry that is not a sampling procedure—some are only more efficient than others. A number of small samples, taken in different parts of the country, or at different times, may be much more valuable than a sample consisting of a complete coverage of one small area. Likewise, sample enquiries spaced a year or two apart may be preferable to a complete coverage of the same area taken every ten years.[4]

As the proportion of any attribute of the population diminishes, a larger and larger sample is required for estimating this proportion with a given degree of reliability. Hence small samples are not adequate to provide data that are to be tabulated in fine classifications, or by small geographic areas, such as small cities or townships. The reason is that in the resulting tables those cells that are to be used for making predictions must not be reduced to a point where statistical fluctuations may disturb the reliability of the predictions. Small samples are adequate, however, for many questions on which data are needed principally for the larger population groupings, cities, states, regions, or for the entire United States, and which in tabulation are to be divided into relatively few sub-classes; for these a properly designed sample will yield results that are as satisfactory for generalizations and courses of action as the results obtainable from a complete canvass, quicker and at much reduced cost. The small loss of precision and detail in a sample is usually much more than offset by the accompanying savings in expense, and such savings open up the possibility of covering a wider territory or conducting several enquiries spaced in time, or carrying a greater number of questions than would otherwise be included on the schedule, or of publishing more tabulations on whatever data are taken.

A striking result of what has just been said is that, except when a census is by definition merely an inventory, small numbers in the cells of a table derived from a complete canvass do not have much significance—no more than if they were derived from a sample. There is a limit, therefore, to the amount of detail that will be found useful in the

[3] Extracted from a letter written by Harold Hotelling to Lester Frankel, dated 30 July 1938.

[4] These ideas are further developed by Samuel A. Stouffer in his chapter "Sociology and Sampling," Ch. xvi in *The Fields and Methods of Sociology*, edited by L. L. Bernard (Long and Smith, 1934), see in particular pp. 478 and 481

cross-tabulation, not only of sample data, but of a complete census. Of course, the limit is reached quicker with the sample data; and the smaller the sample, the quicker the limit is reached.

Some notes on criteria for appraising the adequacy of sampling. In deciding whether the frequency of a certain attribute of the population can be estimated satisfactorily on a sample basis, consideration needs to be given not only to the detail that will be required in tabulation, and the relation of this detail to the proportion p with which the attribute appears in the population (i.e., whether $p=.5$, .1, .01), but also to the question of how much information is already available concerning this attribute. If little is known about it, neither a sample nor a single complete coverage may suffice; a number of samples or complete coverages, separated either in time or space, may be required. On the other hand, when a considerable amount of information has already accumulated, a small sample taken every five years or every decade may suffice for continuity. Thus, questions on parentage have been a part of the census for several decades, and this is one reason why a sample will provide all the new information that is required on this subject.

A sampling method is said to be satisfactory for the questions under consideration if it can be depended on to yield samples (less than 100 per cent) that will lead to the same action as would have been taken on the basis of a complete count. In the usual statistical terminology, the population sampled is the population as it existed at the time the sample enquiry was made. A number of samples taken on this date would be expected to exhibit statistical stability, in the sense that they would all be drawn from the same population. From the point of view being expressed here, however, even a complete census, for scientific generalizations, describes a population that is but one of the infinity of populations that will result by chance from the same underlying social and economic cause systems. This infinity of populations may itself be thought of as a population, and might possibly be called a super-population. A sample enquiry is then a sample of a sample, and a so-called 100 per cent sample is simply a larger sample, but is still only a sample. In order to study the underlying cause systems, it is necessary to study several members of this infinity of populations; i.e., it is necessary to make sample or census enquiries on a number of different dates, preferably far enough apart to be independent, or nearly so.

From what has been said, however, it follows that a sample may be at once satisfactory for the questions under consideration (in the sense of leading to the same action that would be taken on the basis of a com-

plete count), yet unsatisfactory for being representative of an unrepresentative population. Thus, for a severely fluctuating population, even a 100 per cent sample on a particular date may lead to action not at all fitting to the future. For example, at the time the census of South Bend was taken in August 1939, the Studebaker plant was just in the process of preparing for the production of new models, with the result that the number of men at work that week was unusually low, and was in fact very different from the number of men at work the next week. Any action that did not take account of the fact that this was an unusual situation would not have been fitting to the population being studied.

As a basis for action, a sample may be preferable because of shorter processing time. Census and sample are both subject to the common error that arises from the fact that the social order is not static, but dynamic. It takes time to process and tabulate a small sample, but more for a complete canvass. For this reason, in some kinds of enquiries, the complete canvass, by the time it is processed and tabulated, may not be as good a basis for social action as the earlier returns of a sample coverage would have been. To the extent that sampling methods produce quicker results, they also produce more accurate results for purposes of prediction. The error that lurks in predicting the future from the past may thus be greater when the prediction is based on a complete canvass than when it is based on a sample.

The authors have had the advantage of numerous discussions with Drs. Walter A. Shewhart, Harold Hotelling, Leon E. Truesdell, and Philip M. Hauser concerning the interpretation of census and sample data, and express with pleasure their indebtedness to these friends, in particular for the letters quoted in the text.

THE IMPORTANCE OF THE STATISTICAL VIEWPOINT IN HIGH PRODUCTION MANUFACTURING*

By P. L. Alger
The General Electric Company

We in the electrical industry are very much interested in statistical methods, not only because of what they contribute to inspection and reduction of manufacturing losses, but also because they aid in locating and curing production difficulties. We do not look at statistical method as anything theoretical, but rather as a point of view, or way of approaching our practical problems, that is helpful to all concerned.

The statistical expert looks at an overall variation in the final product of manufacturing as the mathematical resultant of a great number of component variations due to differences in the materials as received, in the tools they are shaped with, in the processing they go through and the personalities of the men who do the work. With this viewpoint, the first thought is to measure each of the variations separately and determine the one or more which are important. Generally, he finds that only one or two of the many tolerances involved are important, and he is thus able to put his finger on the particular operation or process which needs improvement. In our Company, therefore, we consider the statistician as a sort of detective or diagnostician who is called in to find and give a name to the source of our troubles. For example, trouble was experienced with oil leaks around a shaft clearance; and investigation of the various sources of error showed most of the variations occurred in a grinding operation. Once this was located, it was a simple matter to add a second or finish grinding operation, which gave the required uniformity with only an occasional production check. This eliminated very expensive delays and reworking, as well as considerable inspection expense.

While many practical men without statistical training can do this work, they are often misled by accepting at face value various pieces of evidence that the statistician can see at once to be unreliable. An appreciation of the number of tests required to secure a representative sample, the way in which different types of errors combine, and the magnitude of error that indicates lack of control, are all necessary for the production engineer; and it is precisely these qualities that the statistical viewpoint conveys.

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The designing engineer having this viewpoint will plot his test results from the production line in the form of distribution curves, enabling him to see at a glance where the mid-point of production comes with respect to passing limits, and how many units are high or low. He will thus be enabled to adjust his design tolerances to the best advantage and to detect the effects of small design changes which could never be determined from test of samples. One instance of this is the case of a frequency relay in quantity manufacture where 15 per cent rejections were experienced for a long time. Plotting a distribution curve of the measurements showed all the rejections to be on the high side so that a simple shift of the calibration setting reduced the rejections to a trivial amount without design or manufacturing change.

The application engineer having this viewpoint will form his specifications in terms of acceptable limits and will establish definite means of checking the allowed tolerances. Having confidence in the laws of probability, he will usually be able to establish occasional sampling or checking tests that will insure the desired quality being maintained at a far less cost than the 100 per cent inspection of component parts which would otherwise be used. If this viewpoint becomes established throughout an organization, a commonly understood language for specifying and controlling production variations grows up, permitting much closer cooperation among the purchasing, designing, manufacturing and selling groups.

The General Electric Company has already established the use of statistical methods in the manufacture or purchase of sheet steel, box board, insulating materials and other items. Also, quality control programs under the direction of responsible individuals are in effect in the production of small motors, fluorescent lamp auxiliaries, watthour meters, superchargers, wiring supplies, plastics, and many other products. Most of the men doing this work are practical-minded without special training, other than a short course in statistical principles; but they have developed a real interest in the subject and have been able to perform quality control work very effectively.

The end result of the quality control expert's work is to establish inspection on the basis of continuing checks on a small percentage of the product, these few test results being used to guide production within the desired limits. A striking example of this is the case of a certain test which was formerly applied to every electric refrigerator. This test required 72 hours on every unit; but now under quality control procedure only 5 per cent of the units are tested and they only have a one-hour test; a reduction of 1440 to 1 in testing time required.

The immediate problem before us all is to get out production. Statisticians can help in this by making available manuals for inspectors, and for quality control work along the lines of that already being done by Mr. Dodge with the American Society for Testing Materials, by Mr. Shewhart of the Bell Laboratories, and by Captain Simon of the Ordnance Department. They can also serve as consultants to industry on numerous problems which are continually arising. I am therefore very glad to learn of the recent formation of an American Standards Association Committee to make expert statistical knowledge available to American industry generally; and I am sure that this program will be of great value to all of us

ON THE INITIATION OF STATISTICAL METHODS FOR QUALITY CONTROL IN INDUSTRY*

By Leslie E. Simon
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In addressing a meeting of statisticians, I am reminded of a statement by a critic of English literature. He said that Milton justified the ways of God to man, whereas Byron justified the ways of man to God. For a number of years I have been justifying the ways of statisticians to unsympathetic representatives of science and industry. It is refreshing to shift position, and now attempt to justify some of the ways of these critical men of practical affairs to statisticians. In doing so, I hope that I may in some measure contribute to a mutual understanding between these groups and promote a unified effort by the two. The leverage effect of an ounce of quality control in the pound of industrial effort has already been demonstrated by many of our larger and more scientific industries. The combination has yielded not only substantial rewards to industry but better products to the consumer. If this cordial relationship can be made more inclusive, the benefits now enjoyed by a few may be extended to the vast bulk of American industries who are still unaware of the economic advantages of the statistical method.

It is well at the outset to consider the statistician in his relationship to science and industry. As a parallel to the old phrase, "Nobody loves a fat man," one might say, "Nobody wants a statistician." What people want is the product of the statistician. They want his scientific techniques *for use as tools in furthering their particular professional ends.* They want his keen aids for summarizing data, for distinguishing between observations, for judging and expressing quality, for detecting variability, and for the economic control of the quality of the manufactured products. The statistician's position is therefore subordinate, auxiliary, and advisory. The responsibility for decision rests with some other person. However, the statistician's position is none the less important for, if experience has proved his predictions to be reliable, it is only with grave misgiving that the user of his product will place himself in jeopardy by acting contrary to the advice of the statistician.

The statistician then has a service or product to offer for the use of

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others in attaining some material or scientific end. Therefore, it appears in order to raise a question regarding the ways and means by which the statistician can promote the wider use of his product and make it have the maximum appeal to the prospective user. In this connection, a lesson can well be learned from the automobile industry. The phenomenal success and increased profits of that industry are due in no small part to a policy of constantly improving the quality of product and at the same time, reducing the price. The statistician can parallel this course and promote his welfare by designing procedures which are well adapted to the attainment of practical ends, and, at the same time, rendering himself non-essential to the operation and application of his procedures.

I mean by this that the essential position of the industrial statistician is that of a designer of procedures and of a trouble shooter in difficult problems. It follows that the procedures which he designs must be of utmost simplicity in application. This implies no lack of merit—in fact, it is an important point in encouraging the broader use of statistical methods. Simplicity of procedure solicits the confidence of the practical man. Those who are associated with scientific work, or with large industries which employ competent research staffs, have difficulty in realizing the degree to which the rank and file of industries cling to the past, resist the novel, maintain smug satisfaction in their time-tried rules-of-thumb, and tend to distrust the theoretical for no other reason than that it is theoretical. Simplicity of procedure is an entering wedge into this broad field which needs the statistical technique so keenly.

Simple procedures, applied by persons other than the statistician, are a necessity if there is to be any immediate use of statistical methods for quality control on a large scale. There are simply not enough statisticians to go around. Furthermore, the application of statistical methods is a logical function of production personnel. Just as the reporter has a nose for news, so production men have a keen ability for discovering the causes of trouble once the existence of the trouble is called to their attention by the statistical technique. The production man is likely to be better qualified to apply the statistical procedure than the statistician who designed it. Furthermore, the mass-production problem is essentially repetitive in nature and does not require immediate supervision of a professional character, once the use of a statistical procedure is properly under way, and a state of statistical control has been attained with respect to the product. This is a routine work, the detail of which can be administered by men of clerical grade.

Since industrial quality control is likely to assume a position of great *importance in the immediate future, I would like to call attention to* some considerations in the design of simple quality control procedures.

No doubt the virtue of the quality control technique inheres in no small measure in its fortuitous combination of engineering and statistical competence. An analysis of process data with a view to finding a cause of trouble or to an improvement in process is possible without the use of formal statistics. This method of keen native judgment and hard commonsense is used day in and day out and eventually it yields some measure of success. However, it is wasteful, time-consuming and inefficient. On the other hand, the statistician with no engineering knowledge of the process is perhaps less equipped for the task than the unaided engineer. In this connection Mr. Louis C. Young in a recent paper before the American Society of Mechanical Engineers said:

> If an industrial statistician is not thoroughly familiar with the process which he is subjecting to statistical analysis or experimentation, he should give no more interpretation to the results of the analysis than is afforded by the hypothesis upon which his methods are based.

It is therefore evident that in the design of a quality control procedure, the statistician must study the production lines upon which the quality control procedure is to operate, until he is thoroughly familiar with all of their technical details; or else he must work in close cooperation with an industrial engineer who has some knowledge of statistical methods. In this connection, the statistician should carefully note the ways in which the statistical method can be of material aid to the process, for he above all others should be assured of the contribution which he has to offer, before being a party to the investment of time and money in a new technique.

Having obtained a combination of engineering and statistical competence which will almost certainly include some notions as to the character and magnitude of variability to be expected in various quality characteristics of the product, one can then consider the basic structure of his quality control procedure.

Dr. Shewhart's work, the experience of the American Society for Testing Materials, the American Society of Mechanical Engineers, and various industrial firms show that the vast majority of useful information which it is economical to get is contained in a measure of central tendency and a measure of dispersion. Therefore, it may be assumed that in the majority of cases, quality control procedures will be concerned with control charts for these two measures. The commonly used measures are the average and standard deviation or the average and

the range. The other important structural member of the quality control procedure is the sample size. The choice of statistics and choice of sample size must be considered together as both have an important bearing on the precision of results. In this connection one should observe that statistical efficiency may be quite different from industrial efficiency. For example, if observations consist of linear measurements of piece parts, it may cost considerably less to take a few additional measurements and use a simple statistic such as range, rather than take fewer measurements and use a more efficient statistic such as standard deviation. On the other hand, if sampling is costly and destructive, such as firing complete rounds of large caliber ammunition or testing samples of armor plate, then the labor of taking a few square roots, instead of an additional observation, may be well merited. One should, therefore, weigh the economic aspects of increased sampling versus the use of more efficient statistics with a weather eye ever on the simpler procedure. In finally coming to a decision regarding statistics and sample size, one should also consider the physical and engineering interpretation of the techniques, their appeal to the engineer, industrialist, or executive; and tend to choose the technique which has the appeal of concreteness to the engineering type of mind.

In assembling the principle structural members of the quality control procedure, the economic point of view cannot be kept too thoroughly in mind. One must carefully consider the economic aims of the process and the ways in which the statistical method may further their attainment. In order to design a quality control procedure, the aims of the procedure must be clearly defined. Some of the contributions which quality control can make to process are:

a. Greater uniformity of product,
b. Larger volume at no increased cost,
c. Reduction of cost of inspection,
d. Reduction in wastage,
e. Detection of trouble,
f. Avoidance of trouble,
g. Authentic record of the quality of product.

Avoid the temptation of attaining basic scientific knowledge which is not of immediate economic value. The statistician is often of an analytic type of mind and may suffer greatly from the temptation to try to find out just what makes things tick. In the early stages of quality control, one must move swiftly toward the economic goal, making use of the materials at hand. It is a grubby, down-to-earth, engineering affair. Any proposals of excursions into theory will surely meet with

disapprobation on the part of executives and supervisors. On the other hand, after the procedure has been in operation for some while, a wealth of material will be on hand for investigations of a fundamental character which can be undertaken without inconvenience to the production process. A subsequent study from the viewpoint of obtaining fundamental knowledge is likely to be welcomed most heartily by the management.

The more efficient process made possible through the use of quality control technique is apt to result in the displacement of some personnel. If for no reason other than that of good will, it is important to try to make some provision for their employment. One may tactfully suggest that the displaced personnel be employed in some other part of the plant, or the possibility of increased volume of product with the existing personnel may be pointed out to the management. In this connection, however, one must be very careful about intruding on the logical prerogatives of management.

In this same connection, it might be observed that it is seldom necessary to urge management to extend quality control technique. It may be difficult to get statistical methods started in an organization. Opposition to any change—especially the new and unfamiliar—is to be expected. A change makes the routine worker have to think, at least temporarily. However, once the management has seen the fruits of the statistical method, opposition ceases. The statistician's principal difficulty then lies in finding enough hours in a day to try to satisfy the crowding and increasing requests and demands of management for more and more of his techniques.

Having settled upon the aims of the procedure and its structural framework, one should then fit it to the existing process and personnel so as to alter the *status quo* as little as possible, provided, of course, that one does not sacrifice important fundamental principles.

The transition to statistical methods can be accomplished most expeditiously by careful prior study of the problem and reduction of the quality control procedure to written form. The written form should be clear, curt, and so complete as to require no other adjunct or explanation. It is important that its authority be made manifest beyond question, by having it signed by the management. Even at the expense of some minor sacrifices of principle, it should obviously fit right in with things as they are and avoid any unnecessary emphasis on things as they should be. The quality control charts will reflect the facts. Once the management sees the facts, it will lay ample emphasis on the right way of doing things. Convenience and adaptation to existing cir-

cumstances can be furthered by inspecting for those quality characteristics which have previously been subject to inspection even though some of them may not be of great importance, adding as few new inspections as practicable, and fitting techniques to the limitations of existing personnel. The whole procedure should be reduced to a simple set of functions, steps, and consequent actions, each of which is the clearly defined duty of the incumbent of a designated position—not the duty of a person specified by name—as persons change with extra shifts, illnesses, promotions, etc. Even at the expense of tedium and labor, simple language and engineering terms which are familiar to the personnel should be employed and technical statistical terms which confuse them and arouse resentment should be avoided. Not only the lower echelons but the management itself tends subconsciously to regard the use of technical terms with which it is not familiar as a reflection on its intellectual standing, and sublimates its aroused inferiority complex by hostilely accusing the statistician of hiding his ignorance of process behind his technical jargon.

Delegate clearly defined and routine duties of the procedure to the respective positions or offices such as inspector, foreman, or superintendent, thereby marking the fields of authority and responsibility which exist under the procedure. Where a system of decentralized or partly decentralized inspection is employed, the collection of data can well be made a responsibility of the foreman, since men under his control are available on the job for this work. However, the foreman should not be permitted to use the producers of the article for sampling their own work. He should, instead, be required to do the sampling personally, or use one of his assistants. The interpretation of the record and general supervision of the postings of a number of foremen is a natural function of the inspector. The location of trouble is, of course, an engineering function, and should be made the responsibility of higher authority such as a superintendent.

Define the sampling procedure as to time, number, and manner of accomplishment. The sampling should be timed so as to be appropriate to the process by prescribing that the sample shall be taken every half hour, every hour, every one hundredth item, every buggy load, etc. Prescribe the number of articles to be inspected at each inspection interval—by whom, and how. Further prescribe the exact way in which the records of the inspections shall be kept, who shall keep them, and provide convenient forms for that purpose. The administrators of the inspection process should be provided with multiplying factors, charts,

etc., so that they will neither have to do mathematical or statistical thinking, nor have to refer to any literature other than the published quality control procedure in posting the records.

Since a process not previously subject to statistical control requires more inspection than one which has shown control for some time, provision should be made for subsequently decreasing the amount of inspection in an economic manner. Since the sample sizes should always be small and preferably constant, flexibility can be best accomplished by providing for changes in the inspection interval. The altering of inspection intervals should be made the responsibility of some competent authority such as the chief inspector, with the approval of the superintendent.

Prescribe the action to be taken when points are out of control limits on the record, such as stop the process, hunt for the cause of the trouble, inform the superintendent, etc. In the part of the process which can be made routine, it is advisable to leave nothing to the discretion of the administrator.

When trouble is discovered, the management is always greatly disturbed about its location and elimination and the correction of the defective parts. In the absence of quality control, the confusion is most serious. Steps should be taken to minimize this problem by providing that the increment sampled shall not flow into the production line, until the sampling result is seen to be within control limits. With this provision, the defectives are likely not only to be readily located, but the further examination of the retained defective increment may throw light on the assignable cause of variation in the product.

Finally, arm the quality control procedure with a thinking clause by providing that any case not covered by routine instructions will be referred to a designated office whose incumbent is capable of keen analysis and logical and responsible action. Without a provision of this character the strictly routine and regimented procedure would lead to ridiculous results under the stress of some unusual and unforeseen event. However, with such a provision a quality control procedure can be established which delegates the duties under the process to positions in such a way that the duties are commensurate with the abilities of the incumbents of the positions. *This is conducive both to work well done and employe morale.* The higher echelons are relieved of the tedium of routine duties and the work of simple and less exacting character is accomplished by the lower-paid personnel. The professional statistician is left free to employ his talents to the critical and analytical attack of

data with a view to improvement of existing conditions; and is called upon to work with the quality control procedure only when some condition has arisen which does not yield either to the routine of the quality control procedure or to the engineering analysis of some higher office, such as that of chief inspector or superintendent.

I have tried systems of this type using procedures of a brief and general character for products of similar quality characteristics and using procedures of a very extensive and detailed nature for a wide variety of products of markedly differing quality characteristics. They have been operated initially by untrained personnel; and have continued to operate quite to the satisfaction of the management.

It is my belief that steps such as I have just outlined will make a substantial contribution towards selling statistical methods to industry; and furthermore, it is believed that only by some such measures for delegating the bulk of statistical work to non-professional personnel, can any wide demand for statistical methods be satisfied at the present time.

SOME CONSIDERATIONS INVOLVED IN APPRAISING THE ADEQUACY OF OCCUPATIONAL STATISTICS*

By Gladys L. Palmer
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An evaluation of the adequacy of occupational statistics involves an appraisal of the purposes served by such data and the effects of the source of information and classification scheme used in relation to these purposes. Some occupational statistics are derived as the result of study of those activities in the labor market which customarily take place at occupational levels. The latter include, for example, the registration of job openings and job-seekers and the placement of workers on jobs by personnel offices and employment agencies. Schools, colleges, and industrial plants train workers for specific or related types of jobs. The settlement of labor disputes and numerous other aspects of the functioning of the economic system are conditioned by the occupational environment and have major significance at occupational levels. The data derived in the course of administrative or special-purpose study of these activities are usually limited to a particular occupation, plant, industry, or area, and are seldom reported on a continuous basis.

Other occupational statistics are derived to answer broad questions about the skills and work abilities of a labor supply or the nature of the economic functions performed by a labor force, as one aspect of economic or social analysis. They may be all-inclusive as to occupational coverage in the sense that the entire population of a given area or an entire country may be reviewed. An inventory may be made of the work or services customarily performed by all workers on relief rolls or by all job-seekers registered in public employment offices. Again, all economic enterprises in a region or of a given type may be asked to report in broad categories the nature of the work performed by their employees. Such occupational data are less detailed in character than those derived for administrative purposes, but, because of their wide coverage, they constitute the basic series with which special-purpose data have to be integrated.

If emphasis is placed in this discussion on what may seem to be very elementary considerations it is because the science of occupational statistics is still in the definition and classification stage of development and the phenomena to be measured are complex and constantly changing. No consideration is given in this paper, for example, to problems

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of sampling or trend analysis on an occupational basis. Nor is any attempt made here to discuss the mechanics of schedule enumeration, personal interview, and occupational coding. It is recognized that the efficiency of these seriously affects the adequacy of the data secured, but, for this discussion, other considerations seem to be more important. It is not possible in the compass of this paper to discuss all occupational statistics now being collected, but data from various sources will be cited to illustrate the problems considered.

PURPOSES SERVED BY OCCUPATIONAL STATISTICS

For many social and economic studies, it is not necessary to identify workers by occupational title. It is sufficient to know, for example, that they are employed in certain industries, that they are wage or salary-workers, or that they are professional workers, craftsmen, or unskilled laborers, to mention but a few broad occupational groups. It should be noted in this connection that, in the opinion of some experts, these broad categories, if classified by the industry of employment, give a better economic picture of the work environment than a plan of occupational title identification.

For many administrative purposes, however, identification of specific occupations is necessary, and it is desirable in other connections. To illustrate the problem of title definition and identification, I should like to cite a situation which developed from the recent experience of the defense program. In the award of defense contracts, the availability of a labor supply is one of the factors which has to be taken into account, and, in consideration of the award of contracts for weaving woolen cloth, the question arose as to what areas in the country had unemployed woolen weavers. The Census of Population had discontinued identifying weaving as an occupation in 1920, so its data offered no clues. The Employment Service identified weavers but had no further information available in its occupational inventory system. It was obvious that cotton and rayon weavers might not be able to weave woolen goods, and a special check had to be made to identify the woolen and worsted weaving centers to which the contracts might be awarded. The Employment Service was then asked to identify weavers by the type of cloth on which they work. That request illustrates a characteristic type of problem to be resolved in the collection of occupational statistics.

As is well known, the occupation of weaving has been for some years in the process of change from a craft, which, in the case of work on some fabrics was highly skilled, to a machine-operating job with a

great range in the amount of skill required for the work. In making coarse cotton fabrics, for example, weavers may tend as many as 60 to 80 looms. Weavers on finer cotton goods and on silk, rayon, and woolen goods tend fewer looms, but, when these are automatic, the number per weaver is much greater than when they are non-automatic. Some weavers operate simple box-looms and others complex Jacquard-looms. Woolen weavers making novelty fabrics of complex construction may operate only one, or at the most, two looms. Carpet and rug weavers on broad-looms are also relatively skilled and usually operate only one loom with the assistance of helpers. Many textile plants produce more than one type of fabric and use various combinations of fibres. In plants where cotton, rayon, wool, rayon-and-wool and other fabrics are woven it is difficult to classify the plant under one type of fabric only. Furthermore, weavers in these plants are moved from one material to another, so that it is difficult to designate them by type of fabric.

An arbitrator settling a wage dispute in a particular textile mill or a local employment office supplying weavers for particular jobs would have job descriptions at their disposal and thus be able to classify weavers according to the requirements of the work. But I would venture to predict that no group of textile-employer and labor representatives and occupational experts could be found who would agree on a simple break-down for the occupational title of "weavers" for nation-wide use. For Census of Population purposes, there may be some dispute as to the desirability of identifying "weavers" in a general classification covering all occupations. For the Employment Service reporting system, the use of the title "weavers" is adequate for statistical purposes. It is only for special administrative purposes, such as the illustration cited that further details are needed.

It is therefore recognized that to meet operating requirements and numerous other special purposes not discussed here, occupational data have to be recorded in detailed categories with precision in the use of titles. To achieve this a job description or supplementary work-history information is usually necessary. These additional data serve to improve the quality of the statistics which are reported by operating agencies or in special-purpose studies, although the coverage of such data is never complete.

In the field of general-purpose as opposed to special-purpose data, there are two series of national importance with broad occupational coverage which should be noted. These are the data of the Census of Population and of the United States Employment Service of the

Bureau of Employment Security. They measure two aspects of the labor supply, respectively: (1) the economic function or nature of the services performed by workers in the economic structure of the country, and (2) the occupational and industrial labor markets to which workers are attached. Both of these concepts are generally recognized as important. One series is collected at decennial intervals as part of a broad social and economic description of the population. The other is collected annually as an inventory of the occupational and major personal characteristics of workers actively seeking work through the public employment office system.[1]

In 1910 and subsequent decennial years, information on occupation, industry, and class of worker, that is to say, whether employer, employee, or working on own account, and modifications of these classes has been asked in the Census of Population. The purpose of asking these questions is directed toward securing a picture, first, of the person's function in the economic structure of the country, and, second, of the nature of the services he performs.

All three items, occupation, industry, and class of worker, are taken into consideration in classifying workers occupationally, but purely occupational considerations may be given second place if a distortion of the picture of the economic function would otherwise result. For example, a great many persons are classified in the Census as proprietors. In a strict sense, this term has a legal rather than an occupational connotation. Similarly, many professional persons who are self-employed or who manage or own a business are classified occupationally not under professional workers but as managers or proprietors. As a result, there is some understatement of the number of persons with professional training and experience in the Census results. Since a man's economic function may involve legal and administrative as well as occupational relationships, the occupational data secured in the Census of Population reflect something different than purely occupational considerations. Since the economic function of all members of the population must be accounted for in the Census of Population, the coverage of occupations, industries, and economic functions found in these data presents the widest range of any series.

The concept of the occupational labor markets to which workers are or consider themselves to be attached prevails in the data collected by the public employment offices affiliated with the Bureau of Employ-

[1] Placements are reported by occupation and industry on a monthly basis, and a monthly inventory is taken of registrants in the so-called "defense occupations."

ment Security. In an employment office, the major consideration is the job history of the registrant, regardless of whether he is self-employed or the owner of an enterprise, and, in most instances, regardless of the character of the industry in which he is or has recently been employed. Any industry connotation in the employment office occupational classification is limited to the industrial labor market with which the occupation is most frequently associated.

The occupational labor market to which a worker is assigned for placement purposes by the Employment Service normally corresponds to the "usual" occupation as reported on schedules, but may reflect subjective estimates on the part of both the worker and the placement officer. A worker applies for the work which he thinks he can do or which under certain circumstances he thinks he has a chance to secure. This judgment may or may not be accepted by the placement officer who may reclassify the worker in assigning his principal classification for placement purposes. That the classifications are subject to change is evidenced in the fact that many job-seekers had to be re-interviewed and reclassified when the defense program was announced and new types of job openings became available.

That workers also change their employment office classifications is illustrated in the recent experience of union hosiery workers. A hosiery union official was lamenting the fact that his unemployed members did not know how to register for jobs. In connection with defense re-training projects, a number of unemployed hosiery knitters had registered at their local employment offices for the first time. But to the official's dismay he found that they had registered as knitters. In one city, he sent them all back to register as machine-adjusters, an occupation in which some hosiery knitters had recently been successful in securing work at one of the largest government arsenals.

For most workers, however, the occupation of primary classification, as it is called in the employment office, is the same year after year, and the employment office statistics, in general, measure the occupational labor market to which workers are "usually" attached. Their coverage of all unemployed workers is not complete, since in some industries unions or manufacturers' associations may act as the clearing-house for the exchange of labor. The distribution of active job-seekers or of persons placed through the medium of public employment offices, by occupation, is, therefore, affected by the placement facilities available and the success of operations, as well as by the degree to which job openings in certain industries are filled outside of the system.

THE EFFECT OF THE SOURCE OF INFORMATION USED ON THE ADEQUACY OF THE DATA

The reliability of occupational data will vary with the source of information used. When workers or members of their families report occupational information, it is recognized that there is a tendency toward the upgrading of occupational categories. This may be illustrated by the reporting of a stenographer as a secretary, a bookkeeper as an accountant, or a machine operator as a machinist. On the other hand, when employers report the occupation of workers in terms of job assignments, the effect may be a down-grading of many workers in terms of their customary occupations, as when a carpenter is reported as a fitter or a machinist as a lathe operator. This difference is reflected in a test comparison of the occupations of some 4,500 persons enumerated in the Philadelphia Unemployment Sample in 1938, as reported by employers and by workers or members of their families. A fifth of the total would have been allocated to different socio-economic classes of Dr. Edwards' classification, and differences for a much higher proportion of the total were found in the specific occupational codes that would have been assigned on the basis of the two sets of returns.[2]

If data are secured by household enumeration, the questions are frequently answered by the housewife for all household members. A housewife is as likely as anyone other than the worker concerned, to know what her husband and other relatives do, but the information given may be too indefinite for use in a detailed classification scheme. The terminology may be very precise or vague, ranging from a "veterinary dietitian" to "employee, factory." It is, however, usually cast in the form of the concept of the customary or present or last occupation, rather than a particular job assignment in a plant.

If occupational data are secured from employers, on the other hand, the criterion of measurement is most frequently the job assignment. Although the terminology for describing this may be definite, it is sometimes meaningless in a general-purpose occupation classification scheme. Such terms as "squadman," "trouble shooter," "repairman," "mechanic," and "organization manager," for example, may have meaning in relation to the operations of a particular enterprise but they have no meaning outside of that enterprise. Furthermore, what is recognized as the same work may be returned by different employers in various ways. Numerous examples of this might be cited, but one will suffice. A check made of the duties performed and job titles used

[2] Wood, Katherine D., "The Statistical Adequacy of Employers' Occupational Records," *Social Security Bulletin*, Vol. 2, No. 5, May 1939, pp. 21–24.

by Philadelphia bottling plants, dairies, ice cream factories, laundries, and bakeries for the occupation of "driver-salesman" or "deliveryman" brought to light the fact that 11 titles were used to refer to this job.[3] Some of the titles emphasized the means of transportation used, some whether the deliveries were to wholesale or retail outlets, and others described the work as a departmental function. It is perhaps significant that, if unionized, the workers all belonged to one union, namely the International Brotherhood of Teamsters, Chauffeurs, Stablemen, and Helpers of America, affiliated with the American Federation of Labor.

Occupational data are probably most reliably and precisely reported when obtained from the worker concerned as the result of a personal interview, especially if the interviewer is trained. This is certainly true with respect to data about occupational labor markets. It is, of course, quite possible for a worker to fabricate a complete work record, but if the reports are subject to any further check as in the operation of work relief agencies or public employment offices, this happens relatively infrequently. Even if not subject to check in an operating agency, the securing of a work-history record serves as a fairly reliable statistical check in occupational classification.

Detailed occupational data have seldom been compiled from a self-registration type of census or survey, so that we know rather little about the reliability of such data. To my knowledge, no check has ever been made of household, employer, self-registration, and employment office returns on occupation and industry for the same group of individuals. Such a comparative check as this would be helpful in obtaining more knowledge with respect to the reasons for differences in returns from these important sources of information and would materially assist in the analysis of occupational data.

EFFECT OF THE CLASSIFICATION SCHEME USED ON THE ADEQUACY OF THE DATA

Equally important with other considerations which affect the adequacy of occupational statistics is the classification scheme adopted for presentation of the data. This choice is conditioned by the degree of detail and accuracy of the information available for coding purposes and by the purposes to be served in the study. It should be noted at once that no amount of elaboration in a classification scheme can make up for deficiencies in the original material collected.

Classification schemes which attempt to distinguish between closely

[3] These were: deliveryman, route salesman, driver's helper, shipping department, driver [illegible], wholesale salesman, retail salesman, chauffeur, truck driver, teamster, cab man.

related occupations are predicated on a greater degree of precision in the source data than are those in which groups of related occupations are consolidated in classification. It is possible for the Employment Service reporting system, for example, to distinguish between machine operators in the metal-working occupations who are skilled and those who are only semiskilled. In fact, their original data allow for many more distinctions than are necessary or useful for statistical purposes. Similarly, the Bureau of Labor Statistics in making a study of wages in an industry can define the industry jurisdiction and secure job descriptions as a basis for classifying occupations in considerable detail.

When occupational returns are less precise or genuinely indefinite, and no supplementary data are available, fine distinctions cannot be made. For such data, a classification can identify only the more standard types of occupations, the terminology for which is commonly known and used, and allocate other workers to broad groups having occupational or industrial significance. The introduction of many refinements of detail in a scheme for such data is, in fact, misleading, because few workers are returned in the exact terminology of the title provided and the rest have to be allocated to broader groups. The resulting distribution of workers does not correspond with economic realities.

The principle used for combining occupations into groups which are homogeneous in character is also important. There is a wide difference of opinion on this point with respect to the feasibility of using grade of skill as a major grouping principle in occupational statistics of broad coverage. The skill requirements of industry are constantly changing and the effects of technological change appear to be more generally in the direction of lowering rather than of raising these requirements, although there are some exceptions to this. It is clear that both employers and labor unions have vested interests at stake in any occupational classification scheme based on the grade of skill which is widely used. The cleavage in opinion among technicians as to the feasibility of using grade of skill as a grouping factor may be likened to the cleavage of opinion in the labor movement as to whether labor unions should be organized on a craft or on an industrial basis. In fact, it stems from the same considerations that prompted the union split, and, like the labor movement, the technicians have to say that those data which permit of division according to grade of skill may be classified that way, but for other data some other grouping factor should be used.

CONCLUSIONS

Historically, the way a worker described himself as a worker and the

way in which an employer described the worker's job were usually identical. But the division of labor which accompanied the ramifications of industrial change resulted in manifold aspects of occupational description. For a limited number of professions and crafts, the duties to be performed and the terminology for describing them are the same, whether reported by the employer or by the worker. But for an increasing number of jobs and of workers, there is a wide discrepancy between the duties and the terminology for describing them in a given job assignment in an economic enterprise and the corresponding "occupation" in which a worker has had training or experience.

In addition to this difference in point of view between workers and employers with respect to what the job consists of, is the fact that work is performed in many different ways in different establishments and in different parts of the country. Within a given industry, the specialization of operations may vary considerably and is subject to constant change. Furthermore, in addition to these differences in fact, there are differences in opinion as to the appropriate job title to be used for what is recognized as the same work. This arises from variations in the organization of individual business enterprises which affect work operations and from the importance of customary usage with respect to job titles in a community. Any evaluation of occupational statistics must therefore take into account not only legitimate differences in points of view with regard to the criterion of measurement and the kind of classification to be used, but, in addition, must recognize that the reliability of all data is affected by the absence of a standardized terminology for describing occupational phenomena.

The technicians are in agreement in their opinion that the time has arrived for declaring a truce on independent experimentation with new occupational classification schemes. They believe that careful research has gone into the development of the Employment Service and Census Bureau classifications and indexes. As a result of the work of the Joint Committee on Occupational Classification of the American Statistical Association and the Division of Statistical Standards of the Bureau of the Budget, these two schemes have been made convertible to each other at a level of detail represented in the Convertibility List of Occupations.[4] Both the Employment Service and the Bureau of the Census have made sacrifices in the comparability of present with earlier data in order to secure greater comparability between the two systems and

[4] For a detailed description of this List and its uses, see Palmer, "The Convertibility List of Occupations and the Problems of Developing It," this JOURNAL, December 1939, pp. 693–708; and Whelpton and Hollander, "A Standard Occupational and Industrial Classification of Workers," *Social Forces*, May 1940, Vol. 18, No. 4, pp. 488–494.

the data are to be used. Figures on the average number employed, for example, while adequate for general observation of changes in employment, furnish an entirely inadequate basis for measurement of changes in productivity or industrial accident rates.

Two developments have occurred in recent years which have made significant additions to existing compilations of employment data. Since 1934, three states have joined the group at present comprising fifteen states, cooperating with the United States Bureau of Labor Statistics in gathering data. Minnesota, which had been collecting statistics, has now become a cooperating state, and Indiana and North Carolina have undertaken this responsibility for the first time.[2] The other development has been the progress in compiling social security statistics. The latter have furnished a valuable check on some existing compilations of disappointing scope.[3] Naturally the unemployment compensation data have to be adjusted for the circumstance that employees in small establishments (with less than 8, 5, 4, etc., employees) are not covered. Unfortunately, too, certain groups in respect of which very unsatisfactory indications are available, are not under the Social Security Act. Such is the case as regards the self-employed, casual workers, farm hands, domestics and employees in water transportation.

In alternate years, the Census of Manufactures offers a nearly complete picture of factory employment. Concerns producing less than $5,000 in value are ignored, and the intercensal counts are less complete because a smaller field staff is employed and greater reliance is placed on mailing lists. The current series of the Bureau of Labor Statistics are periodically adjusted to this biennial census. They are based on a very large sample, but about 10 per cent of factory wage workers are not engaged in the ninety industries covered. Only wage-earners are included, although a separate count of clerical employees is made semi-annually.

Since December 1933, increases have occurred in the samples underlying sixty-four of the ninety manufacturing series of the Bureau of Labor Statistics. Decreases have affected twenty-one series, while five

[2] The states, in addition to those mentioned, are Arkansas, California, Illinois, Kansas, Maryland, Massachusetts, Michigan, New Jersey, New York, Pennsylvania, Texas and Wisconsin.

[3] "Two important new sources of information have recently become available in connection with the administration of social security legislation: employers' quarterly reports in connection with Old Age and Survivors Insurance, and employers' monthly reports in connection with unemployment compensation. These reports have been used extensively as a check on estimates derived from other sources, and in some industries they have provided the most reliable information available." United States Bureau of Labor Statistics, *loc. cit.*

have remained unchanged. Increases have not invariably taken place, nor in largest volume, where most needed. As appears from Table I, the samples for the lumber group averaged only 41 per cent. The

TABLE I

COVERAGE OF EMPLOYMENT INDEXES OF THE UNITED STATES BUREAU OF LABOR STATISTICS

	For the year 1939			Oct. 1940
	(I) Em-ployees (per cent)	(II) Man-hours (per cent)	(III) Relative Complete-ness of Man-hour Sample* (per cent)	(IV) Em-ployees (per cent)
Manufacturing	58	53	90	63
Iron and steel	73	70	96	78
Machinery	65	63	97	71
Transportation equipment	86	84	98	86
Non-ferrous metals	55	53	96	59
Lumber	34	32	94	41
Stone-clay-glass	48	44	92	53
Textiles	63	56	89	68
Fabrics	76	72	95	81
Apparel	47	35	74	54
Leather	56	43	77	62
Food	43	39	91	50
Tobacco	75	71	95	80
Paper and printing	48	43	90	50
Chemicals	59	56	95	63
Rubber	87	83	95	94
Anthracite mining	81	71	88	84
Bituminous mining	57	42	74	60
Metalliferous mining	74	73	99	86
Quarrying, etc.	82	77	94	84
Telegraph and telephone	74	72	97	74
Electric light and power	98	82	84	98
Street railways and buses	75	61	81	68
Wholesale trade	22	15	68	23
Retail trade	28	17	61	29
Hotels (year-round)	53	27	51	56
Laundries	32	24	75	35
Cleaning and dyeing	26	20	77	30

Source: Basic data furnished by U. S. Bureau of Labor Statistics.

* Found by dividing entries in column II by corresponding entries in column I and multiplying by 100.

samples for millinery, butter and cottonseed also remained very thin. Four of the samples amounting to less than 50 per cent of the estimated total suffered declines: sawmills, marble manufacturing, baking, and printing of newspapers and periodicals. Considerable increases were

to census data, present monthly fluctuations in employment in coal mines, metal mines, and quarries and non-metallic mines. An index of employment in crude-petroleum production excludes well-drilling and rig-building. Except for bituminous coal, the Bureau's mining samples include over 80 per cent of the employees, and offer hours data for seven-eighths or more of the samples (Table I). In bituminous mining, only 60 per cent of the employees are included, and hours data cover only three-fourths of the sample. The data are also not as representative as could be desired, either as to size or location. The indications of the Bureau's mining series are reasonably accurate, and will improve if more frequent censal counts can be arranged.

Information regarding employment in the construction industry is incomplete and unsatisfactory. The first Census of Construction collected data from 144,000 firms the value of whose business was less than half the total value of construction in the United States in 1929. With due allowance for the decline in employment, the firms consulted appear to have employed less than half the number of workers listed by the Census of 1930 as employed in the building industry. The industry was again canvassed as part of the Census of Business in 1933 and 1935, but the coverage improved only slightly. Fluctuations in employment on construction projects financed in whole or in part from Federal funds are very accurately measured. Data on non-Federal construction are extremely unreliable. The present sample of the Bureau of Labor Statistics is small, representing about 10 per cent of the workers engaged in private building construction. The appearance and completion of particular jobs and the formation and dissolution of small firms are the principal factors the effects of which incomplete monthly reportings cannot be expected to measure. The Bureau's current estimates of total nonagricultural employment continue to include extrapolations based on their reportings, until unemployment compensation data become available. In 1939, the estimates missed the peak in building activity by 100,000, an error of nearly 10 per cent.

The Census of Occupations and the quinquennial Censuses of Agriculture give approximate indications of total farm employment. For the intervening periods, employment may be estimated by referring to the series on family workers and hired laborers per one hundred farms, based on the monthly statements of crop reporters. The Department of Agriculture warns that their sampling of farms is hardly representative, being overbalanced in favor of large units. Some difficulty is also experienced in separating hired from unpaid workers. The tendency for

shifts to occur as between these groups in response to economic changes enhances this difficulty. The figures on unpaid workers are probably overlarge, including some family members not engaged in agricultural work.

Farm employment must be measured with due regard to part-time farming if overlapping is to be avoided. In 1934, approximately one-twelfth of the man-hours of agricultural employees were in off-farm employment. Some of the half-million workers who toiled at nonagricultural pursuits for over one hundred fifty days may have been counted both as farmers or hands, and as industrial workers.

There is virtually no information on changes in employment in forestry and fishing. The procedure of the National Industrial Conference Board in making its monthly estimates is indicative. The 1930 figures (Census of Occupations) are adjusted by reference to the Bureau of Labor Statistics index of employment in saw-mills, as regards forestry; and by reference to changes in agricultural employment, as regards fishing. Fortunately the number involved is small, seldom rising above 260,000.

The Bureau of Labor Statistics indexes of employment in wholesale and retail trade are periodically adjusted to the totals reported in the Census of Business.[4] In her illuminating article in this Journal Miss Joy reported coverages of 22 per cent for wholesale trade and 28 per cent for retail trade, and pointed out that the retail sample was unrepresentative both as to size and location.[5] The samples have been expanded slightly, but efforts to correct the weaknesses detected by Miss Joy have failed. In 1939, the retail sample included 57 per cent of employees of general merchandising establishments, but only 20 per cent of employees of other retail establishments. The data are quite indicative as to department stores and chains, and quite misleading as to small stores and restaurants. Will simple expansion of coverage improve matters? The cost of securing broader coverage of small establishments is considerable and the rewards uncertain. No way has been found to measure the effect produced by the short life of a considerable proportion of small stores and restaurants. Accordingly indexes may continue to understate increases and overstate decreases in employment, even with a much broader sample. There is reason to think that the Censuses of Business have been misleading in this regard.

[4] The retail trade index is adjusted to the 1935 Census, the wholesale trade index to the 1933 Census. The later census made no breakdown as between full-time and part-time workers in wholesale trade.

[5] Joy, Aryness, *Recent Progress in Employment Statistics*, this Journal, December 1934, pp. 365-69.

Annual estimates of employment in finance are reasonably indicative. The Bureau of Labor Statistics gathers monthly data on insurance and brokerage establishments, but avoids formalizing them as index numbers. No monthly data on banks are collected, but this is a minor matter since bank employment is very steady. The Conference Board projects monthly fluctuations as regards finance using a three-month moving average of employment in trade, assuming a corresponding movement but with lower sensitivity.

The situation with respect to domestic and personal service is less satisfactory. Monthly reports to the Bureau of Labor Statistics from hotels, laundries and cleaning and dyeing establishments can be related to corresponding data in the Censuses of Business. The indications for year-round hotels are rather good, but the samples for laundries and dyeing and cleaning establishments seem unrepresentative as well as small. The difficulty encountered in connection with small stores is also found in hand laundries and small cleaning establishments. When they become available, unemployment compensation data offer much information on business, repair, and personal service firms. As for the residue, including most domestic pursuits, little information is available except the annual estimates made by the Income Section of the Department of Commerce.

One of the weakest points in our measures of employment is in estimating the number of self-employed. The industrial censuses make available a tabulation of proprietors in the industries concerned. Special studies and analyses of various professional bodies occasionally present data indicating the number of some class of professional person. Other proprietors and independent workers can be identified as such only at the time of the decennial Census of Occupations, and then with some difficulty. Whether or not there are significant monthly fluctuations in the volume of employment of the self-employed, no way has been found of measuring them. The monthly estimates of the Bureau of Labor Statistics will be found to assume a constant number of self-employed persons.

Measures of employment in the United States have been considerably improved in recent years. Greater accuracy continues to obtain as regards industry than agriculture, and as regards either than the services. Man-hours indications are slender except in manufacturing, rail transportation, mining and the utilities. This limits the adequacy of employment data for computing earnings, productivity and accident rates.

The gaps, some of which have been indicated, show that existing data permit only an approximate estimate of total employment. In Table II the various portions of a total employment estimate for June

TABLE II

APPROXIMATE RELIABILITY OF EMPLOYMENT ESTIMATES, JUNE, 1940

Good

Error 3 per cent or less

Industry	Millions
Manufacturing (employees)	9.3
Mining (employees)	0.8
Steam railroad (employees)	1.2
Utilities (employees)	0.6
Federal Government*	1.6
Total	13.5

Fair

Error 4–6 per cent

Industry	Millions
Trade, wholesale and large retail (employees)	2.5
Agriculture, independent	6.2
Street railway (employees)	0.3
Finance (employees)	1.0
Total	10.0

Poor

Error 7 per cent or more

Industry	Millions
Self-employed, casuals and domestics	6.1
Agriculture, workers†	5.0
Forestry, fishing (employees)	0.2
Transportation other than rail (employees)	0.8
Service workers	2.8
Trade, small retail (employees)	3.5
Construction workers	1.2
Public employees, other than federal	2.4
Total	22.0

Total

Good	13.5
Fair	10.0
Poor	22.0
Grand Total	45.5

Sources of estimates: United States Bureau of Labor Statistics and National Industrial Conference Board.

* Including federally financed construction.

† Including unpaid family workers.

1940 are assembled under three heads, depending on their relative reliability. For many items, it was possible to secure statistical demonstration, by comparing the indications of samples with those of an industrial census or adjusted unemployment compensation data. In some cases, the considered judgment of those engaged in framing estimates was sought. In a few cases, items known to have little or no foundation were automatically placed in the "poor" category. The estimates for thirteen and a half million of the employed are listed as having a margin of error of 3 per cent or less. Estimates covering ten million of the employed have a margin of error of from 4 to 6 per cent, and for twenty-two million, of over 7 per cent. All in all, we should be fortunate if the total of forty-five and a half million erred by less than 6 per cent, or over two and a half million. It is not as if the errors were,

in general, likely to prove offsetting, for the tendency to underestimate is overwhelming.

Present employment estimates are closer than even a few years ago. We should certainly continue to make them and to refine our techniques for doing so. We need more complete and indicative tabulations. Those interested should press for more frequent censal counts in a larger number of industries, more extended efforts to broaden the base of available samplings, and, most important of all, intensive study of the special measurement problems of specific industries. In efforts along all these lines the American Statistical Association has already made important contributions.

ADEQUACY OF DATA IN THE FIELD OF PUBLIC AID*

By Herman M. Somers
National Resources Planning Board

General periodic censuses are not taken in the field of public aid nor are there in existence agencies whose sole function is the expansion of knowledge in this area. In the field of public aid, statistical and research data are derived almost exclusively as by-products of the administrative process. The type of administrative structure is therefore the principal determinant of the kinds of basic data which will be available in this broad field.

When, before 1936, public aid was largely within the jurisdiction of a single Federal agency (the Federal Emergency Relief Administration), which could enforce a uniform national reporting system, our statistical data were more complete and clear despite the omission of some small programs. Since the proliferation of public aid programs and administrative agencies on federal, state, and local levels, we have also had a proliferation of data. But statistical collections and the research are done by individual units within the several administrative agencies. As a result the data appear to have lost some of their completeness, uniformity, and clarity, reflecting the vast complexity at present prevailing in the provision of and administrative structure for public aid.

We now have statistical series for a large number of individual programs emanating from different agencies and special inquiries confined to single programs, but they are frequently impossible to add up, or to compare, or to interpret. Terms differ, units of measurement vary, dissimilar time units are employed. And since the Federal Government abandoned its participation in general relief, virtually no national data have been available for that program.

Each agency collecting data has as a primary responsibility the administration of its particular program or programs, and data to be collected, research undertaken, and definitions employed are determined primarily by agency needs. There is no agency charged with the responsibility of looking at the problem as a whole, of putting the pieces together.

I point this out not only to clarify the source of several of the difficulties to be enumerated later, but to make it immediately clear that it would be inaccurate to construe what I have to say about inadequacies as a criticism of the statistical units within the several agencies.

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 28, 1940.

Some of these units have been making continued and independent efforts, against great odds, to unify series and to enhance comparability. In fact, the progress which has been made is a credit to the broader interests and vision of certain statisticians, particularly in the Social Security Board and the Work Projects Administration, who have appreciated the necessity of going beyond a narrow concept of administrative research and have tried to overcome the present administrative handicaps towards the development of adequate statistics. But their power has been limited.

I will not attempt to list the data available and the data not available in the field of public aid, nor will I attempt to cite all the technical difficulties and limitations of available data. The field of public aid is now vast and complex; the forms of aid and the types of administration are multifold; general relief in cash and in kind, work relief, aid to dependent children, old-age assistance, youth work programs, programs for youth in school, aid to farmers, surplus commodities, and social insurance. Some programs are administered directly by the Federal Government; some entirely by local authorities; some by grants-in-aid involving simultaneously all three levels of government; some by a combination of Federal and state governments; some by a combination of the state and local governments. Nor is each program administered the same way for all sections of the population. The general relief program is administered in a staggering variety of patterns throughout the country. Even on a single level of government we have examples of entirely separate agencies participating in the same form of aid. Two distinct agencies on the Federal level, for example, are concerned with the administration of unemployment compensation.

To lend better perspective to the entire problem, let us assume that we here have been assigned to a large study of the relief problem of this Nation, and that we have been given responsibility for the statistical section of this study. It is not our task to undertake any original research but to gather together and interpret the significant available data in this field. We will not attempt a very exhaustive study but we will devote our attention to certain broad obvious questions which stand out as primary considerations which we must take into account before our study can proceed very far. In the course of attempting to find the answers to these questions we will soon have some indication of the adequacy of present data.

If we were able to sit down in conference, at least five broad questions would suggest themselves for initial exploration. We would soon agree that the answers to them represent basic essentials for our knowledge. These questions are:

1. How many people are being aided through public provision?
2. Where are these people located?
3. What are the significant social and economic characteristics of these people?
4. How much aid are these people receiving and how adequate is this aid?
5. Do these enumerated people represent the entire needy population or is there an area of unmet need?

I think you will agree that I have not selected obscure or narrow questions for which the need of an answer should first be debated and defended. Let us then proceed to find the answers to our questions. To simplify our problem we will concern ourselves only with non-institutional forms of aid.

First, "How many people are being aided through public provision?" Our first difficulty, and a peculiarly complex one under the circumstances, is to define public aid and determine what programs we are to include. Since my views on this question were expressed in a previous paper, I will refrain from entering upon this lengthy question here.[1] For convenience, let us here accept the programs included in the monthly series currently published by the Social Security Board and the Work Projects Administration.[2]

We find first that the several series representing the different programs are difficult to compare. In some cases the unit of count is the entire household or family (as in general relief), in some cases it is a single person recipient (as in Civilian Conservation Corps and National Youth Administration), and in some cases portions of families (as in Aid to Dependent Children). We, therefore, would be hard put to it if we attempted to compare the number of households benefiting from different programs. For example, we would have no way of knowing from the published series to what extent several boys from one household were enrolled in Civilian Conservation Corps camps simultaneously. We would have similar difficulty with Old-Age Assistance and National

[1] See, *Second National Conference of State Directors of Research and Statistics in Public Assistance Agencies, October 1939.* Social Security Board, Division of Public Assistance Research, Washington, D. C., 1940, pp. 100–121. My major point of disagreement with the present series was the inclusion of regular public works and construction projects of the Federal Government. The point has become more apparent since the development of the defense program. Defense activity is causing an expansion of these projects and so we find the striking anomaly that defense expenditures are a cause of apparent increase in the public aid totals.

[2] Since this paper was delivered, the Joint Committee on Relief Statistics of the American Statistical Association and American Public Welfare Association, of which the author is a member, has recommended to the Social Security Board and to the Work Projects Administration that their series be revised to exclude employment and payrolls of regular construction projects of the Federal Government. It is expected that the agencies will publish revised series at an early date.

Youth Administration because of duplications within those programs. General relief is the program which is reported strictly on a household basis, but it is important to observe that national data for general relief are in part estimated, as six states do not have complete reporting systems. We would find further that the methods of counting recipient units are not identical. For general relief, the three special categories of public assistance, Farm Security grants, and National Youth Administration we would find the total number of different cases which received aid during the month, but for Work Projects Administration, Civilian Conservation Corps and other Federal work projects, we would find the average number of workers during the month. In high turnover months the differences resulting from these varied methods of count might be considerable.

These difficulties are somewhat resolved if the object is to obtain a single figure for the total number of different households receiving one or more of these aids in a single month, because the Social Security Board and Work Projects Administration cooperate in attempting to remove duplications[3] within and among programs (which are very substantial) and publish an estimated unduplicated total of households. Although the agencies involved are doing a conscientious and able job, the basic data from which the over-all figure on households is derived are admittedly inadequate.

An equally important basic figure for our purposes is the number of different persons (as differentiated from households) who receive aid. The same difficulties which I mentioned for households, i.e., different methods of count of the number included in the grant and of how many were aided during the month, also apply more pronouncedly to the persons count.[4] But whereas data on cases are presented for all programs in some form, data on persons are not available on a national basis for general relief, and not at all for Farm Security grants, and Work Projects Administration. Estimates made are necessarily rough. As a result, the estimate of the over-all number of persons receiving public aid during recent years has increasingly become subject to doubt.

Finding ourselves with a somewhat questionable figure for the number of households and the number of persons receiving aid during given

[3] The problem of duplication involves more than concurrent receipt of aid from two or more programs by one household. The transference of a household from one program to another within the same month will also result in the counting of the same household on the rolls of both programs.

[4] In general relief, for example, the method of counting the number of persons within a household benefited by a grant varies from state to state. In some states, members of the household receiving other forms of aid, such as old-age assistance, will not be counted in the general relief grant. In other states, all members of the household are included.

months, we must raise the question as to whether we have adequate totals. Recipients of surplus commodities are not included in any published series unless they are included by virtue of simultaneous receipt of aid from some other programs. Originally, such a procedure was valid because the objective of the program was the removal from the market of farm surpluses and the distribution of commodities was to supplement current relief only and in no case to substitute for it. Actually, in many places, surplus commodities have replaced general relief grants and, particularly in parts of the South, the surplus commodity program has become *the* general relief program; it is the only form of general relief available. Because of its doubts regarding the accuracy of reports from the states, the Surplus Marketing Administration, until very recently, has not made available figures on the number of households receiving surplus commodities and no other form of aid. During some months of the past year nearly one-half million households in the United States would fall into this category. Obviously, the omission of such data may represent a considerable understatement of the recipients of public aid in this country.

Now, there will undoubtedly be among us some who feel that the data on social insurance should be coordinated with relief data on the ground that unemployment compensation, for instance, is a form of public aid providing against loss of income due to unemployment (unemployment itself being the presumptive evidence of need rather than a formal means test). We would unfortunately find that we could not carry out such a coordination. There is no way at present of translating individual recipients of unemployment compensation into number of household units, nor do we have any idea of how many persons are contained in such households, and only for restricted areas can we say how many such households receive other forms of aid and thus appear in other series.

Despite such limitations, in general it can be said that data are available for the total number of recipients of public aid by months, assuming, as I stated before, agreement upon the programs to be included in the total. But a month is an arbitrarily limited period of time and in effect gives us simply a snapshot or a still of the situation. For perspective we should also know how large a portion of the population is dependent upon public aid over a more significant period of time, such as a year, or perhaps over the course of a depression. No such data are available, not even official estimates. You may presume that data on turnover rates would offer some clue, but this is not the case, not only because of the well-known fact that identical persons appear in turn-

over data several times during the year but because there actually are no turnover data available on relief status. Although we have knowledge of turnover on Work Projects Administration and more limited approximations for general relief, we do not know to what extent the separations in these programs represent a termination of relief status rather than a transference to another program. We do know that shifts from program to program within relief status are considerable.

We now turn to question 2, "Where are these people located?"

I have indicated that we can acquire official estimates of the unduplicated number of households and persons who receive one or another form of public aid (exclusive of social insurances). But since the United States is a rather large place we could not make much headway towards proper comprehension of the problem if we did not break down our data in at least two general ways: by states or at least regions, and by size of community or urban-rural distribution. We would soon find that neither of these things can be done or has been done in several years. Although the persons who prepare the estimates of the unduplicated totals for the Nation feel that the fragmentary data with which they must work give a reasonable view for the country as a whole, they could not venture any estimates for smaller geographic areas, not even for broad regions. Should you wonder whether the use of gross totals in the programs might not render a close enough approximation, it must be pointed out that for the programs as a whole duplications may run above 20 per cent and that there is little uniformity in the phenomenon. For instance, generally speaking, duplications are apt to be very much greater in the North than in the South, because of differences in relief standards.

It is, however, possible to compare data for individual programs by states and regions, even if they cannot be added together. This is, however, not possible with respect to rural-urban distributions. Figures for certain of the programs, like the special public assistances, are available by size of community. But some important programs, notably the Work Projects Administration and the National Youth Administration, have data only by counties. These counties are classified by the size of the largest community within the county, which, needless to say, does not always offer an accurate picture of the county as a whole.

Some of you may at this point be thinking, in view of the great difficulties in getting any over-all view of all the programs, that it may perhaps be sufficient to look at individual programs or portions of the problem. Such a view would be highly questionable, but even if we were interested in only a portion of the total problem, say the problem

of youth on relief, we would have similar difficulty. Because the methods of count vary, we could not put together the data for the Civilian Conservation Corps and the National Youth Administration, the two specific youth programs, let alone the fact that there are large numbers of youth provided for through other programs such as Work Projects Administration and general relief of whom we would also have to take account.

We now turn to our third broad question, "What are the social and economic characteristics of these people?" Why are they on relief?

Certainly we should want to be able to state in our study some indication of the causes of dependency, going a little deeper than the vague truism that it is all a result of the absence or loss of income. What proportion of the load is dependent because of unemployment? What proportion because of sickness? What proportion because of inadequate earnings from full-time or part-time employment? Unfortunately, I think, we would be forced to resort to what economists sometimes call "informed guesses."

The significance of a classification of the relief population by the types of problems they represent is apparent the moment we realize that this vast section of the population is widely differentiated, and therefore requires differentiated treatment, and we try to determine what types of programs would be most appropriate for them. It is, for instance, definitely not true that a return to full employment will solve the relief problem. But at present the agencies engaged in relief administration are faced with the query: to what extent will the current expectation of a return to approximate full employment succeed in reducing the relief load? Lack of knowledge of the employability characteristics of the relief population proscribes any satisfactory answer. We can set minimum and maximum limits but the range between them is tremendous.

Not since October 1933 has there been a complete census of the relief population—and even that census included a very limited number of questions. Not since January 1936 has there been a census of the occupations of relief workers.

Today, we can only roughly estimate the age composition of the relief population, their race, their sex, their work histories, their occupations. Sample studies give us only a vague notion about the duration of their unemployment. We know little about how many workers there are in relief families. How many of the so-called employable portion of the relief population are normal workers and how many have always been casuals? How many are marginal workers for whom it would be

unreasonable to expect a return to private employment although they retain limited productive capacities? We do not even know how long people receive public aid.

For individual programs there are answers to some of these specific questions, and fragmentary data can be found for all programs.[5] But only by the most agile statistical manipulation could one put such data together. For one of the important programs, general relief, one has to rely exclusively on fragments derived from a few cities and states (heavily concentrated in urban areas) on all these questions.

We know most about the recipients of the three special public assistances—old-age assistance, aid to dependent children, and aid to the blind—but those are in any event the most stable and predictable portion of the relief population.

By and large, I do not believe it can be gainsaid that we know painfully little about the characteristics of households and persons receiving public aid. Yet, until we have such knowledge, it is difficult to contemplate an orderly program which would provide differentiated treatment for different groups conforming to their needs, and to the economic and social interest of the Nation as a whole.

The fourth question we have posed for ourselves is "How much aid are we giving these people and how adequate is this aid?"

In one form or another data are available program by program on the average monthly benefits or payments per case. For the special public assistances, specific analyses have provided frequency distributions, at least for initial grants. For Work Projects Administration wages data are available distributing employees by wage classes (although the exact earnings, which frequently differ, are not available in this form). There is little of value, other than the average, available for general relief.

As I have indicated before, it is very common for more than one aid to enter the same household or family. The data for individual programs are therefore not sufficient to tell us how much individual households are deriving from public aid. For the Nation, as a whole, an arithmetic mean can be struck by dividing the total amount of payments by the estimate of the unduplicated number of households, but such a figure is of very little value. No indication of the distribution can be derived,

[5] State and local agencies are now proving the old adage that a little knowledge may sometimes be dangerous. Inquiry has shown that even at present when State WPA agencies are called upon to describe the characteristics of their workers, they use the last available data, gathered in February 1939, despite awareness that important legislative and economic changes may have changed the facts. State and local public assistance agencies use detailed data on new special assistance cases to describe the entire load, even while acknowledging that such data are no longer representative.

nor the range, nor even a median. As to the differences between states and regions, the absence of any data on total number of households precludes even an arithmetic mean. We are equally unable to make comparisons between benefits going to rural and to urban families.

One of the important uses of such data would be as guides to the adequacy of the benefits in terms of some given standard of living. But even the availability of data on amount of benefits per case would not be sufficient. We would need to know the size of the household dependent upon the public aid and be able to relate these figures to the size of benefits.[6] We should need the location and size of the communities in which the recipients reside and what other sources of income enter such families. Finally, we must have some gauge of the costs of some accepted standard of living for different types of communities.

What I have said previously should indicate that we are not able to answer any of these questions. I believe that if you were to question research people engaged in this field you would find the large majority designating as the most important gap in our present knowledge the fact that we know almost nothing about the adequacy and varying standards of public aid in the United States.

We now turn to our last question, "Is aid being made available to all persons in need?" The difficulties faced in the attempt to answer our previous question recur here to a great extent. Not knowing the standards of relief practice for different areas and not having a gauge of what should be regarded as minimum, approaches to this question must be indirect and inferential.

Too frequently people have assumed that data on the number of cases receiving aid indicate the extent of need or that fluctuations in the number of cases indicate the change in need. It is unnecessary to remind this audience that data on relief extended are influenced by legislation, current administrative policy, and available funds, as much as by volume of need.

Various indications are available of the enormity of the unmet need problem. One agency has made an estimate of how many more cases would have to be aided if we assumed an equalization of standards throughout the country based on the standards actually existing in some of the more liberal states. Another attempt has been made to measure this problem by use of the data derived from the 1935–36 Consumer Income Study of the National Resources Committee.

[6] It should also be noted that households receive aid for varying lengths of time within the same month; some for a few days, others for the entire month. Cases cannot be distinguished by duration of relief in the monthly reports.

Both these methods are extremely rough but both indicate that unmet need, in terms of the number of households receiving no public aid, may run into the millions. Another indication is available in the fact cited before that perhaps one-half million households receive surplus commodities as their only form of public aid and over three-quarters of a million not receiving any other form of public aid are certified as eligible for commodities. Incidentally, a closer coordination of surplus commodity and other relief data would do much to clear up many questions in regard to standards.

I need not belabor the significance of knowledge on the question of unmet need. It is tragic, in terms of public policy, that a satisfactory answer to this question is not available.

I have not begun to touch upon many of the significant questions which would have to be considered in any exhaustive statement on public relief statistics. Some of these questions may be even more important than those I have mentioned. For instance, how are the public aid programs financed, what are the differential costs of different methods of administration, and what effect do the programs have upon the beneficiaries? I have assumed that in a brief paper of this nature my purpose would best be served if I indicated the general types of difficulties presently faced in this field by use of broad examples.

The picture I have painted appears very bleak, to some extent because I am forced to confine myself to broad generalizations and cannot cite specifically some of the bright spots. In order not to leave an unbalanced picture, I am anxious to state that continuous progress is being made in this statistical field. With new programs and new agencies budding and expanding rapidly during the past few years, the statistical task has been terribly difficult and fraught with obstacles which have to be overcome one by one.

However, as I indicated earlier, no one agency will be able to solve the difficulties alone. Here is a task for a coordinating body, capable of taking the broadest view and in a position to enlist the utmost cooperation from all relief agencies at every level of government. Such a body should be concerned not only with the requirements of individual programs and the problems of consistency and overlapping but also with the gaps—the present no man's land—thus making possible the data essential to an evaluation of the sum total of all the programs.

COST FUNCTIONS FOR THE STEEL INDUSTRY*

By Mordecai Ezekiel and Kathryn H. Wylie
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LIMITATIONS OF A STEEL COST CURVE

The cost function measures the relation between volume of output and cost of production. The cost may be expressed as total cost, average cost per unit, or marginal cost per unit. According to traditional theory, the cost of each volume of output should reflect the least cost combination of the factors of production for that volume of output. It is doubtful whether it is possible for the management in practice to approximate the theoretical least cost combination at each varying level of output. It is likely instead that rule of thumb reasoning is frequently followed, with perhaps conventional combinations of number of men with rates of operation and given equipment and machines according to the standard practice in the industry. When we determine the changes in cost per unit which actually occur in a given plant or industry as output changes, it will thus not necessarily reflect the theoretical least cost combination of factors, but instead the combinations which actually have been employed at each of the varying levels of operation.

It would require a very complex investigation to go back of the relations between output and unit cost which have actually prevailed to determine how the combination of different factors at every level of output has affected cost and how a more efficient combination might have been secured. Some slight progress in this direction has been made with respect to farm operation in farm management studies, and it may be that efficiency engineers have made some progress toward it for simple industrial processes. There seems to be very little information as to the shift in combination of factors, or even as to the cost function itself.

It may be useful to try to determine the relations between volume of operation and production cost for broad industrial aggregates, even if that has to be done without the refinements which would be involved in a study of the effect of combinations of factors on costs.

This paper is a discussion of some of the possibilities and limitations of a cost curve for an industry as a whole, using the steel industry as a basis.

When we try to develop a cost curve for the steel industry as a whole, or for a single unit of that industry, such as the United States

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Steel Corporation, we are confronted with the difficulty that the final products are the result of a series of many industrial operations. The data cover the over-all operations of a highly integrated industry, with many different plants involved at the various stages of production. For one of these plants the least cost per unit might be reached at 80 per cent of capacity, and for another it might not come until it was operating at 90 per cent of capacity. Also, the final products are varied, with the proportion of each constantly shifting. When one type of plant is producing at 80 per cent of capacity, for example, another type may be working at only 50 per cent, and another may need to be expanded beyond its present potential output. An average operation rate of 60 per cent for the entire industry may therefore lump together widely varying rates within the individual plants covered by that average.

In the steel industry the raw materials pass through numerous operations to reach the end products, all under a single integrated ownership. The large concerns produce much of their own raw materials from coal, ore, and limestone mines or quarries. They operate plants for converting the coal into coke, and blast furnaces into which are charged the coke, limestone, and ore. The iron, pig or molten, may be converted into wrought iron or refined into steel. The steel ingots next are turned into slabs, sheet bars, and other products in roughing mills. The finishing process is in turn divided into numerous operations handled by many different plants within the same concern. These include shape mills, forging presses, universal and sheared plate mills, rail mills, wire mills, and sheet mills. At various stages in its manufacture the steel may be combined with other materials to produce steels of varying strength, durability and use. These many operations involve transportation of the materials from plant to plant, by rail, water, or road, often in facilities owned by the concern. Transportation and assembly costs may make up from 20 to 50 per cent of the cost of the material.[1]

The relative proportion of the different products varies from time to time according to the demands on the industry. In periods of low capital-goods construction the lighter and highly fabricated products, such as steel sheets, become relatively more important, while at other times steel rails, beams, and other heavy products are more important. The accuracy of any average cost curve for steel as a whole is, there-

[1] *Iron and Steel*, Report No. 128, 2nd Series, U. S. Tariff Commission 1938, Chap. 1; *Economics of the Iron and Steel Industry*, Daugherty, De Chazeau, and Stratton, Vol. I, Chap. II, 1937; *Hearings before the Temporary National Economic Committee*, 76th Congress 2nd Session, Part 18, Iron and Steel Industry, Appendix.

fore, further limited by these changes in the average composition of the product.

Since so many different end products trace back to a common source in the blast furnace, it is practically impossible to separate cost elements for a particular product. The only thing which can be done as yet is to attempt to get an average cost curve for the finished products which throws together all the cost elements in the different processes. This average cost curve is further complicated by the fact that products other than steel represent a considerable item in the sales of the companies concerned. Since we are dealing with joint costs, both with other steel products and with by-products such as cement, the cost function developed for the steel industry is more or less arbitrary.

For each item of cost in each plant and for each product then, there is a different cost pattern. For each of the finished products the cost function is complicated and interdependent. The composite cost function over the entire industry is a conglomerate of all of these individual curves, and may or may not coincide with any one of them.

POSSIBLE USES OF A COMPOSITE STATISTICAL COST CURVE FOR STEEL

Despite the limitations inherent in a composite steel cost curve, a determination of such a curve could be useful in a variety of ways. Within the industry itself it is important to know to what degree different factors affect costs and earnings, what effect could be expected if the plant were being utilized at or near full capacity in contrast to a less full utilization, or what might be the result of an increase in the wage rate to employees.

In the field of economic and industrial adjustment, it is essential to have some conception of the cost functions in our major industries to see how they can work most effectively together in the general welfare. Concentration of economic power in industries such as steel has become so great that its policies and operations may have far-reaching repercussions throughout other industries.[2] Price and production policies in an industry depend in part on its cost function. Decisions based on an incorrect impression of the relation of cost to output may result in widespread unemployment not only in the steel industry itself but in industries which utilize steel as their chief raw material. In a highly mechanized world such as ours steel reaches out into many industries and its policies affect the operation of the entire economy. If any in-

[2] T.N.E.C. Monograph No. 1, *Price Behavior and Business Policy*, Senate Com., by Paul Nelson and Walter C. Reim.

dustry is to perform its maximum function in the total economy, it should understand both its own cost and demand practices, and the interrelationships of its price and production decisions with the other industries of the economy.

In addition, our defense planning requires such information about our major industries that it may be most effective. Since steel is one of the major raw materials of defense, knowledge of the cost functions in that industry is particularly important. The prices which the Government will pay for steel might be directly related to costs at different levels of output. Excessive profits might easily result from inadequate knowledge of these relations. On the other hand, the industry itself might be adversely affected by the adoption of an unduly low price structure without adequate knowledge of these relations.

STATISTICAL DETERMINATION OF COST CURVE

Two different and independent studies of the steel cost functions have been made recently. One was made by Dr. Theodore Yntema for the United States Steel Corporation, and was submitted to the Temporary National Economic Committee.[3] The other was made by the present authors.[4] Both studies were based upon data for the United States Steel Corporation.

The cost concept used in both studies was the commercial definition of cost—that used by the Corporation in keeping its accounts. No attempt was made to separate the indirect costs and prime costs of economic theory. It would probably be quite impossible to do so from the published records available. Dr. Yntema's study was based on actual charges made by the Corporation in its accounts. Our study was based on estimates which represented efforts to approximate those charges as closely as possible.

In Dr. Yntema's analysis, the cost items for different years were adjusted to 1938 conditions. A separate analysis was made of each item of cost as it related to the weighted average production each year from 1927 through 1938. The estimated cost under 1938 conditions from the separate analyses were added together to obtain the composite cost formula. In our analysis we analyzed depreciation and depletion separately, but the remaining costs we converted to a cost per unit basis which we treated as the dependent variable in a multiple correlation analysis. Cost per ton was related to per cent of capacity operated (as

[3] Hearings before the T.N.E.C., Part 26, *Iron and Steel Industry*, "Steel Prices, Volumes, and Costs," Washington, 1940.

[4] Mordecai Ezekiel and Kathryn H. Wylie, "Cost Curve for Steel Production," *Journal of Political Economy*, December, 1940.

reported by the Corporation), wage rates, price of steel scrap, etc. Four analyses are presented in our published document, two for quarterly and two for annual data. The annual studies were based on the years 1920 through 1934, and the data for subsequent years used to test the reliability of the results. In most cases, the fit on this extrapolation was reasonably satisfactory. In Dr. Yntema's study, no such test of the results secured by their extrapolation to subsequent data has yet been published.

NATURE OF THE COST CURVE

These analyses reveal the general character and extent of the cost curve for the United States Steel Corporation. Both Dr. Yntema's study and our study indicated a similar cost curve for the Corporation. The relation of depreciation and depletion charges to production was found to be about the same in both. Since the two studies were so different in method, the results for costs other than depreciation cannot be compared directly. It was necessary to extrapolate our curves to 1938, the year used as a base by Dr. Yntema, to make a comparison. Figure I, taken from our published study, shows the curves of total cost under 1938 conditions as derived from the two studies.

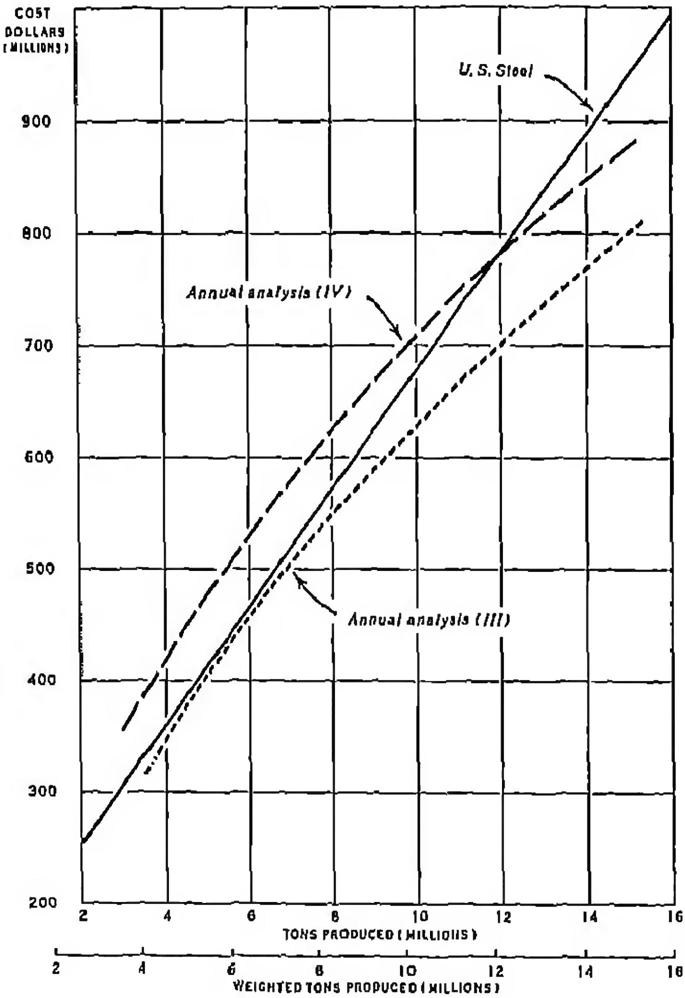
Both of the annual analyses from our study produce a total curve less steep than that of Dr. Yntema. His study shows a straight line relationship which is carried down to the point of zero production, with a constant charge per ton above that point. The total costs shown by our study are curvilinear, with marginal cost per unit declining as output rises. No estimate is made for cost at zero operation, since there has never been a time during the period of the analysis when there was a zero operation rate.

The relative level of the three cost curves is not very significant, since slight differences in the weight assigned to individual factors (such as wages) can make material difference in the level of the curves for particular years. The estimate from our study was extrapolated four years beyond the period used in making the analysis, and 1938 was a year of high wage rates. Had the comparison been made for some other year, such as 1925, the relative position of the curves might have been different.

When the three curves shown in Figure I are converted into average cost per ton at various levels of output, all three show the cost declining sharply up to 50 or 60 per cent of capacity. (See Figure II.) Above 60 per cent the absolute cost per unit continues to decline, but the rate of decline is much less. Both analyses on an annual basis from our study

show a steeper curve for the higher rates of operation than does Dr. Yntema's curve.

FIGURE I
TOTAL COSTS OF STEEL PRODUCTION UNDER 1938 CONDITIONS
Excluding Taxes and Interest

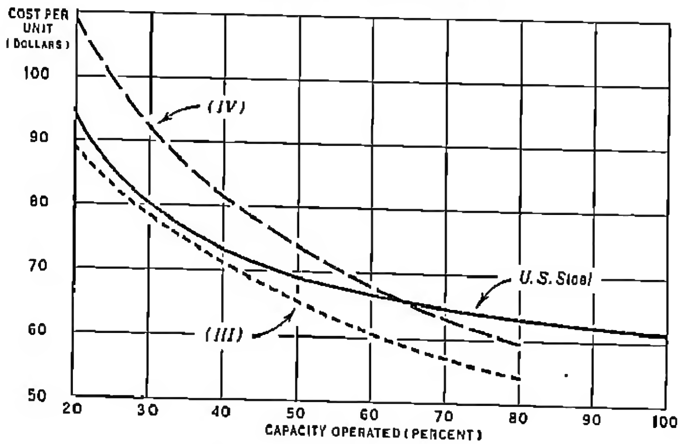


The following table shows per unit costs from the three analyses at several levels of operation, and the percentage changes in costs from 20 to 50 per cent of capacity and from 50 to 80 per cent.

Per cent capacity operated	Average cost per ton of steel: Yntema analysis		Ezekiel and Wylie Analyses: No. III		No. IV	
20	$93.81		$88.95		$108.83	
50	69.38		65.23		73.95	
Per cent reduction		24.0%		27.5%		32.0%
50	$69.38		$65.23		$73.95	
80	63.29		54.11		59.63	
Per cent reduction		9.0%		17.0%		19.0%

Between 20 and 50 per cent operation our analysis number III and Dr. Yntema's analysis give results which are very similar, the decline in cost being 3.5 percentage points greater for our analysis than for his. At higher rates of operation, however, per unit costs decline much more in both our annual analyses than in his. The standard error of the re-

FIGURE II
RELATION OF TOTAL COST PER UNIT OF STEEL TO PERCENTAGE OF CAPACITY OPERATED, 1938 CONDITIONS



gressions from our analyses indicates that the reliability of the regressions at both low and high capacity operation is not very high, so that only the general shape of the curves at each extreme can be determined.

However, the differences in the results secured in Dr. Yntema's analysis and in our analyses for operations above 50 per cent of capacity suggest that a reconciliation should be attempted to determine which, if either one, is more nearly correct. The steepness of our curve for this range of output indicates that operations could be profitable at lower prices than does his relatively steep total cost curve for output above 50 per cent of rated capacity.

The monthly figures of production of steel ingots in per cent of

capacity operated, for 1920 through 1939, indicate that production fell below 20 per cent of capacity in less than 5 per cent of the months, and below 30 per cent in only 15 per cent of the months.[5] Production exceeded 90 per cent of capacity in only 15 per cent of the months, and was below 80 per cent 65 per cent of the time.

It appears, therefore, that over the past 20 years steel has been produced a considerable proportion of the time with such a low utilization of plant as to involve a cost per ton materially higher than would be possible with a sustained fuller use of the existing capacity.

Neither analysis shows any point of rising marginal cost as production increases. Presumably if output reaches the point where many idle, obsolete plants are brought back into use and where much inexperienced labor has to be employed, rising costs might result. During the period analyzed, with production rising up to 89 per cent on the annual basis, or 101 per cent on the quarterly figures, there was no apparent indication of such a point being reached.

One of our annual analyses separated labor costs from other costs, and determined a cost function for each separately. These results are quite interesting from the light they throw on the frequent assumption in economic theory that labor requirements necessarily rise as output moves toward fuller utilization of plant.[6] The relation of labor requirements to output, under 1934 conditions, is as follows:[7]

Operations in per cent of capacity	Labor employed per ton of steel produced *Man Hours*
20	60
40	47½
60	42
80	36
90	33½

[5] Ingot production is not exactly comparable with production of finished steel as used in the study.

[6] This assumption is repeatedly stated by J. M. Keynes, for example, in his *General Theory of Employment, Interest, and Money*, New York, 1936. Thus on page 17 he says "It is true, of course, (owing to the fact of diminishing returns to an increase in the employment applied to a given capital equipment), that *any* increase in employment involves some sacrifice of real income to those already employed. . . ." See also pp. 42–43, 83, 121, and 257. However, in his subsequent article, "Relative Movements of Real Wages and Output" in the *Economic Journal* for March, 1939, Mr. Keynes admits there is some question as to the validity of this assumption. He concludes with the statement, "I urge, nevertheless, that we should not be too hasty in our revisions, and that further statistical enquiry is necessary before we have a firm foundation of fact on which to reconstruct our theory of the short period." The statistical analysis here referred to indicates that both average and marginal labor requirements per unit fall as output rises. We are, however, dealing only with one concern in the industry. It might be that with greater utilization of capacity in the entire industry, small, inefficient concerns would be brought into production and the marginal labor requirements for the industry as a whole would thus increase. Whether or not that would happen would depend upon the ability of the several large producers, such as the United States Steel Corporation, to meet the demand within their own capacity, and upon the concurrent behavior of steel prices.

[7] This table is based on the net regression shown in Figure II of our article, *loc. cit.*

Instead of increasing with larger output, as theoretically expected, average labor requirements per unit fall sharply as output rises. This is true not only of the average requirement per ton, but also of the marginal requirement. Transformed into marginal costs, the data just given show a continuous fall in the marginal labor requirement as output rises, with output per additional man hour about three times as large at 90 per cent of capacity as at 40 per cent of capacity. If this relation is found to hold true in other mass-production industries such as automobiles, cement, aluminum, etc., material revisions may be required in much of current economic theory to make its assumptions consistent with the facts of a major part of modern industry.[8]

The declining marginal costs in steel production, and the marked decline in average cost per ton as output rises, both persisting at least up to very nearly the rated full capacity, suggest one reason why industrial profits in the past have varied so widely with changes in the volume of industrial output.[9] They suggest also that if the price policies which have characterized these heavy industries in the past could be modified toward passing on to consumers or to workers more of the savings that come with larger volume, it might be found possible, even in the absence of defense expenditures, to maintain full utilization of capacity over longer periods, and for a larger proportion of the time, than it has been found possible in the past. The pros and cons of such new price and wage policies, and the changes in our economic institutions which would be necessary to make them feasible for the concerns involved, lie outside the scope of this paper.[10]

[8] Available data on labor requirements in automobile and cement production indicate that somewhat the same relation holds in those industries as in steel. See Ezekiel, *$2500 a Year*, pp. 180–82, 1936, and *Jobs for All*, pp. 28–30, 1938.

[9] La Rue Applegate, First quarter industrial earnings show less than usual decline relative to business activity, *The Annalist*, May 6, 1940.

[10] For a discussion of some aspects of these issues, see *The Structure of the American Economy*, Part II, "Toward Full Use of Resources," the National Planning Board, 1940, especially the sections by Alvin H. Hanson and Mordecai Ezekiel, pp. 27–45. See also the final chapter of the *Technical Report of the Temporary National Economic Committee on Economic Planning as a Means to Increased Production, Employment and Income* (in press).

SOME THEORETICAL IMPLICATIONS OF THE STATISTICAL ANALYSIS OF DEMAND AND COST FUNCTIONS FOR STEEL*

By Jacob L. Mosak
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The failure to attain full employment and to utilize the Nation's economic resources effectively during the last ten years has produced a vigorous and stimulating discussion of the obstacles to economic expansion. In this discussion one of the major questions at issue has been the rôle of price inflexibility in restricting production and employment. On the one hand, it has been contended that the failure to reduce prices, particularly in the durable goods industries, has been a major factor in contributing to the severity and duration of the depression. On the other hand, it has been maintained that a general reduction in prices without a corresponding reduction in wages would have been impossible without bankrupting industry generally. Some have argued instead that it is the failure to reduce wages relative to prices which has been largely responsible for unemployment. To this, Keynesians have generally replied that a reduction in wages would lead only to a corresponding decline in prices and would leave employment unchanged unless interest rates could be reduced sufficiently. Still others have argued that because the propensity to spend is different for wage earners than for non-wage earners, both with respect to magnitude and with respect to timing, wage reductions might even reduce employment.

On this broad question of the relationship of general price and wage flexibility to the full utilization of economic resources, the Steel Corporation's statistical analysis of the demand for steel[1] is of little help. It relates only to the short-run effect of an isolated reduction in the price of steel unaccompanied by changes in prices elsewhere, or changes in national income. This analysis indicates that the demand for steel is inelastic in the short run with respect to such isolated steel price changes. Since the steel cost generally constitutes only a small fraction of the final price of products made from steel, and since the

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I am indebted to Professors O. Lange, J. Viner and T. O. Yntema, and to Mr. H. G. Lewis for their helpful suggestions. None of them, however, is to be held responsible for any of the statements made in the text.

[1] U. S. Steel Corporation, *Temporary National Economic Committee Papers*, New York, 1940, Vol. I.

short-run elasticity of substitution between steel and other materials is generally low, the demand for steel is relatively unresponsive in the short run to changes in steel prices. A given relative decrease in steel prices, all other prices and income remaining constant, gives rise to a smaller relative increase in the quantity of steel demanded. It follows, therefore, that an isolated reduction in steel prices would reduce not only the net revenues of steel producers but also their gross revenues.

This analysis of the "Marshallian" elasticity of demand, therefore, shows that isolated steel price reductions for the purpose of stabilizing output and employment cannot be profitable for the steel industry. It has little significance, however, for the problem of whether and to what extent it may be possible to increase output and employment generally by means of a general reduction in prices.

The conclusion as to the unprofitability of isolated steel price reductions for the steel industry appears to be valid even if we consider the longer-run elasticity of steel demand. The longer-run elasticity is probably greater than the short-run elasticity for at least two reasons. First, the direct and indirect increase in income resulting from an increased output of steel and products made from steel would of itself indirectly lead to a further increase in the purchases of steel products.[2] It is difficult to estimate the magnitude of this secondary income effect, but it might perhaps be about as large as the primary price effect. Second, the elasticity of substitution between steel and other materials is undoubtedly greater in the long run than in the short run. For relatively new and experimental products made from steel, the elasticity of substitution might in crucial periods prove to be great. The price of steel might, for instance, be the deciding factor as to whether or not an innovation is adopted, and a new market for steel is developed. It is safe to assume, however, that the steel industry would be eager to exploit such opportunities if and when they arose. For old, well established products, however, it is unlikely that even the long-run substitution of steel for other materials is very large. This is particularly true since a reduction in steel prices is likely to lead to a reduction in the prices of rival materials, thereby lessening the substitution effect. This means that barring such factors as technological innovations, the elasticity of demand for steel cannot be very large even in the long run.

The analyses of the cost of steel production indicate that the elasticity of demand for steel would have had to have been about three and one-half in 1938, before it would have been possible to reduce prices

[2] This point was also raised by Dr. Mordecai Ezekiel before the Temporary National Economic Committee hearings on steel. Verbatim Record, January 24, 1940.

from 1938 levels without affecting steel profits.[3] We may, therefore, conclude that the elasticity of demand for steel cannot normally be so large as to make price reductions profitable for the steel industry. Even if the long-run elasticity were conceivably so large that a reduction in steel prices could increase future steel profits, such a reduction would involve absorbing definite current losses in the hope of realizing possible future gains. It certainly cannot be contended that the long-run elasticity is so great as to warrant a reasonable expectation that future profits would offset current losses.

It must be emphasized, however, that this finding on the unprofitability of steel price reductions relates only to the effect of an isolated change in steel prices unaccompanied by a *general* fall in prices or in the prices of durable goods. If, for instance, the adoption of a policy of price reductions by the steel industry should lead to or be associated with the adoption of similar price policies in other major industries, there is nothing in the statistical analysis of the demand and cost functions presented by the United States Steel Corporation, which sheds any light on the effects it would have on output and employment. In the case of a simultaneous price reduction in industry generally, the really crucial factor is the effect it has upon the level of monetary expenditures for goods. If the money expenditures can be maintained or at least prevented from declining to the same extent as prices,[4] output and employment will expand despite the inelasticity of

[3] If we let v be the net revenue, x the volume of output, y the average price per unit, and c the total cost of production, then $v = xy - c$. If the net revenue is to remain constant when the price is reduced then we must have

$$\frac{dv}{dy} = x + y\frac{dx}{dy} - \frac{dc}{dx}\frac{dx}{dy} = 0. \tag{1}$$

Letting $e = \frac{dx}{dy}\ \frac{y}{x}$ be the elasticity of demand, the elasticity would thus have to equal

$$e = \frac{-y}{y - \frac{dc}{dx}} \tag{2}$$

if a small price reduction were to leave net profits unchanged.

It is interesting to note that Professor Leontief assumes that the Steel Corporation does set its price to maximize its net revenue, and uses equation (2) to estimate the actual elasticity of demand for the Corporation. See Wassily Leontief, "Elasticity of Demand and Cost Data," *American Economic Review*, December 1940, XXX, No. 4, pp. 814–817.

[4] This writer is doubtful of the efficacy of a general price and wage reduction policy during a downswing, when the volume of money expenditures is declining. Such a program might even aggravate the depression by decreasing labor income and expenditures and by giving rise to expectations of further price cuts. He would be more confident of its effectiveness once an upswing has been started through a significant increase in investment expenditures. See Alvin H. Hansen, "Price Flexibility and the Full Employment of Resources" in *The Structure of the American Economy, Part II: Towards Full Use of Resources*, National Resources Planning Board, Washington, 1940, pp. 27–34.

demand for any individual commodity. The conclusion which emerges from the steel findings, therefore, is this: if the elasticity of demand for most well established manufactured goods is low, it is useless to expect industries to undertake individually a program of expansion of output through a reduction in prices. To each industry individually it would appear unprofitable to reduce prices and expand output, since an isolated price reduction by that industry would reduce its net revenue.

It should be noted that the inelasticity of the total market demand for steel is not in itself a sufficient explanation for the failure of the steel industry to reduce prices during depressions to the extent desired by the critics. For the degree to which the price differs from the marginal cost of production depends not simply upon the elasticity of total market demand but upon the competitive interrelationship between firms. If the relationship between firms were such that any one firm believed it could increase its sales significantly without significantly affecting the sales of competitors, there would be a great downward pressure on prices during depressions despite the inelasticity of the market demand. In the ideal case of pure competition, prices would always equal marginal costs despite the most extreme inelasticity of total market demand.

In the steel industry, however, where eight firms have more than 80 per cent of the total ingot capacity, this downward pressure on prices is considerably weakened. Since a reduction in the price of steel by any one firm would significantly affect the sales of competitors, each firm must consider the probability that a reduction in its price will soon be met by the competing firms. This consideration generally serves as a powerful deterrent against price-cutting, since a price-cut that was met by competitors would increase sales only slightly. It should be noted, however, that this consideration does not work in the same degree in the reverse direction to stimulate price increases. For when a price increase is being contemplated, there is not the same degree of probability that competitors will also increase their prices. The uncertainty in the mind of each producer that, although competitors could increase their net revenues by meeting his price increase, they might prefer to keep their prices unchanged and take business from him, generally serves as a deterrent against price increases, despite the inelasticity of the market demand.[5] This uncertainty, however, may be reduced by the basing point system of pricing.

[5] Compare Sweezy's statement that the "imagined demand curve" for an oligopolist has a "corner" at the current price, and that this "corner" results in price rigidity. Paul M. Sweezy, "Demand Under Conditions of Oligopoly," *Journal of Political Economy*, XLVII, August 1939, No. 4, pp. 568-573.

A more important problem arising from a consideration of the statistical demand and cost functions for steel is the problem of setting competitive standards for the steel industry. On the demand side we know that the demand for steel, as for durable goods generally, is characterized by severe cyclical fluctuations, since it is a function of actual and anticipated changes in consumers' income and industrial profits as well as of actual and anticipated prices. On the cost side, the findings of the United States Steel Corporation[6] indicate that with a given set of raw material prices and wage rates the marginal cost of production for steel is a constant for the entire range of output experienced by the Corporation. The findings of Dr. Ezekiel and Mrs. Wylie[7] indicate that with given prices and wage rates the marginal costs may even be a decreasing function of output for that same range. It follows that with given prices and wage rates the average costs of production are always higher than the marginal costs for the experienced range of output. Under these conditions, it is perfectly clear that if prices were always equal to marginal costs, as they must be under pure competition, it would be impossible for the steel industry to cover any of its overhead costs so long as the present capacity were not severely over-taxed. This means that over the cycle as a whole the steel industry could not have met its fixed costs, given the present volume of investment in the industry.[8]

This type of reasoning appears to have been presented by some economists as an argument against the possibility of maintaining pure competition in the steel industry, even if the present firms could be forced to disintegrate. Thus, in his article "Toward a Concept of Workable Competition," Professor J. M. Clark writes:

> A price which at all times covers only short-run marginal cost would lead to large operating deficits whenever demand is short of capacity, and would

[6] "An Analysis of Steel Prices, Volume and Costs," *T.N.E.C. Papers*, Vol. 1, United States Steel Corporation, New York, 1940.

[7] "The Cost Curve for Steel Production," *Journal of Political Economy*, December 1940.

[8] As Professor Viner has pointed out, to the extent to which raw material prices and wage rates for the steel industry are an increasing function of the output of steel, adjustment of monetary costs for variations in these prices and wage rates tends to lower the computed marginal costs of large outputs and to raise the computed marginal costs of small outputs. Thus, while the marginal cost may be a constant or even a decreasing function of output when raw material prices and wage rates are given, it may be an increasing function of output when allowance is made for the positive relationship between raw material prices and wage rates and the steel output.

It does not appear, however, that this qualification is of sufficient importance to invalidate the conclusion in the text that if prices had been made equal to marginal costs, it would have been impossible for the steel industry to cover its fixed costs for the cycle as a whole, given the present volume of investment in the industry. A rough, admittedly unsatisfactory indication of this fact is given by the scatter diagram relating *unadjusted* total money costs of the Steel Corporation to its steel shipments. A straight line appears to give a satisfactory fit to these points. See "An Analysis of Steel Prices, Volume and Costs," *op. cit.*, Chart 1, p. 10.

bankrupt most industries, no matter how shockproof their capital structures. And since the horizontal individual demand curve of pure competition leads to a price that covers only marginal cost, it is not one of the conditions of workable competition. Instead the requirement is an individual demand curve with sufficient slope to bring price, on the average, far enough above marginal cost so that average cost may be covered, over the run of good times and bad.[9]

It seems to me important to emphasize that the severity in the cyclical fluctuation of steel demand and the constancy of the marginal cost of steel production are not theoretically inconsistent with the existence of pure competition. For even though the marginal cost is constant or even decreasing throughout the observed range of production, it is perfectly obvious that it must at some point become an increasing function of output. For outputs above 100 per cent of rated capacity, the short-run marginal costs of production probably increase very rapidly. For such outputs the marginal costs are above the average costs of production, and a price equal to marginal cost would be higher than the average cost. All that would be required under pure competition therefore, is that during the course of the cycle there be a sufficient period when each plant operates at a point where marginal cost is above average cost to offset the losses made during the depression when the plant is required to operate with marginal costs below average costs. This condition sets a limitation upon the volume of investment that can exist in this industry under pure competition. The volume of investment will be only so large as to permit the average cost for each plant to be just covered for the cycle as a whole, the profits in periods of prosperity being just sufficiently large to compensate for losses during all other periods.[10]

Perhaps it should be specifically pointed out that we are here abstracting completely from the question whether there could remain a sufficient number of producers in the industry to meet the requirements of pure competition. To separate out the single issue which concerns us here we are arbitrarily assuming that the number of remaining firms would be sufficient to meet the requirements of pure competition and we ask the question whether constancy of marginal cost and severity of cyclical fluctuation in demand are in themselves theoretically inconsistent with pure competition. Professor Clark, if I interpret him correctly, answers this question in the negative. Thus he argues:

[9] *American Economic Review*, Vol. XXX, No. 2, June 1940, p. 250.

[10] In a footnote to his article, Professor Clark states that this argument was also made by Professor George Stigler during the discussion of his paper at the Round Table of the American Economic Association and the Econometric Society in December 1939.

> In the ordinary course of modernization and replacement, the stand-by units (the best units which are just not good enough to justify keeping them at continuous or nearly-continuous operation) are not likely to be sufficiently obsolete and inefficient to bring their marginal costs of operation up to a point that would yield large profits for the plant as a whole: large enough to offset operating deficits incurred most of the time, and to make the average represent an attractive return on investment.

And two paragraphs further he writes:

> The industry could not survive under prices which were always limited to marginal costs of the short-run variety, unless it deliberately destroyed its superseded units instead of leaving them to serve as stand-by capacity and thus created an artificial bottleneck on industrial expansion. And that may be dismissed as a possibility, for reasons hardly necessary to state.[11]

On the basis of the reasoning indicated previously, Professor Clark's argument appears to me to be erroneous. It is possible to have pure competition whether or not stand-by units are maintained by any firm. The sole requirement is that there be only enough investment in the industry to permit each firm to cover its average costs over the cycle as a whole. It is true, of course, that the transition from the existing situation to one in which prices were always equal to marginal costs would render valueless a good deal of investment. For if investment in the industry at present is such that the marginal cost of production does not increase sufficiently even in peak years, obviously not all of the investment could remain if prices were forced down to marginal costs. But once enough investment left the industry, so that during prosperity years the remaining firms would be operating at sufficiently high marginal costs to offset their losses in depression years, the industry would be fully adjusted to the cycle. There would be no further tendency for additional investment to leave the industry, nor would there be any reason for destroying any stand-by units in depressions. We conclude, therefore, that cyclical fluctuations of demand and constancy of marginal costs are not theoretically inconsistent with pure competition.

The results under such a hypothetical system invite comparison with those under the present system. In order to avoid any confusion at this point, it is important to state that in setting up pure competition as a standard of comparison, we are not in any way implying that pure competition should or even can exist in the steel industry, in the economy generally, or, for that matter, in any part of the economy. Every economist is, of course, aware that pure competition is an abstraction rather than a description of reality, past, present or future.

[11] *Op. cit.*, pp. 260–61.

It may even be admitted that the actual market is not a very good approximation to the economist's abstraction of pure competition. Nevertheless, this does not render the concept of pure competition useless. We may still use it as a standard of comparison to see how the results in any imperfectly competitive market differ from those which would exist in the "theoretical" case of pure competition.

In making this comparison, it should be noted that we are assuming, as presumably did Clark, that the general business cycle would not be significantly affected by the existence of pure competition in the steel industry. We are thus comparing the present situation with one in which only the steel industry is forced to sell at prices equal to marginal costs, all other industries continuing their price policies as at present. For as has already been indicated, if there were to be a general change in price policy for the economy as a whole, the entire nature of the cycle might be seriously affected, although whether it would be dampened or aggravated is still a matter of controversy. It should also be kept in mind that we are arbitrarily assuming that the cost functions for the individual plants would remain unaffected by the change from the present situation. In actual practice the cost functions for production proper would very likely go up as a result of the change, although selling, transportation, and management costs might go down. On balance it appears likely that cost functions would rise. It should perhaps be pointed out, therefore, that the comparison made in the next paragraph may have little or no significance or may even be misleading as applied to the steel industry. Nevertheless, it raises interesting theoretical considerations which may be significant for many other industries that have also experienced constant marginal cost and severely fluctuating demand, but in which technical economies of large scale production are not so important.

Assuming that at present only average costs are covered by the producers in the industry, it is clear that more steel capacity is supported by the present system than would be required under pure competition. This means that for the cycle as a whole the price is higher and the output lower than it would be under pure competition. This difference in price depends upon the difference in average cost over the cycle as a whole. The average overhead cost is, of course, greater under the present system, but it must not be forgotten that the average variable costs would in periods of prosperity be higher under pure competition. For the cycle as a whole, therefore, the difference in average total cost is not as large as might appear at first sight. A second advantage of pure competition over the present system lies in the nature of the

cyclical fluctuations in prices and output under the two systems. During depressions prices would be lower and output higher, while during prosperity prices would be higher and output lower than under the present pricing system. For prices, the cyclical fluctuations would have a greater amplitude but the average would be lower; while for output, the amplitude would be smaller but the average would be higher.

These conclusions appear undeniable so long as we compare the present system with one in which the steel industry alone operates under pure competition, and in which the cyclical fluctuations in steel demand can be foreseen with accuracy. Unfortunately, however, we are only human beings, constantly plagued with uncertainty. And once we admit the existence of uncertainty, it is possible that pure competition should produce certain disadvantages which might be sufficient to overbalance any of the previously enumerated advantages. For it is a notorious fact that human expectations are perverse in several phases of the cycle. During a major part of the upswing when prices and production are rising, people generally expect them to rise still further. On the other hand, during a major part of the downswing when prices and production are falling, people generally expect them to fall still further. Under these circumstances any factor which increases the amplitude of fluctuations of prices and profits is very likely to increase the fluctuations of investment and disinvestment.

If prices were made equal to marginal costs in the steel industry, prices and profits would be considerably higher during the upswing and considerably lower during the downswing. It is likely, therefore, that there would be a considerable increase in investment during the upswing which would prove to be unprofitable over the cycle as a whole. This excess investment would then be balanced by a greater volume of disinvestment during the downswing. For the cycle as a whole, this excess investment and disinvestment is, of course, a complete waste of resources. This waste may be greater than under the present system in which a greater volume of capacity is maintained than would exist under pure competition with correct expectations, but in which the smaller amplitude of profit fluctuations probably reduces the amplitude of fluctuations in investment. Thus, once we admit incorrect expectations which tend to aggravate cyclical fluctuations, it appears that equating price to marginal cost in an industry with severe cyclical fluctuations in demand and with constant marginal cost, may increase rather than reduce the wasteful use of resources. In other words, increased cyclical price flexibility may intensify rather than reduce the

cyclical problem of output and employment because of the effect of price changes upon business expectations.

Whether this stabilizing influence is of sufficient importance to warrant maintaining the status quo with respect to the price-output policy of any given industry is a matter for careful consideration in each specific instance. A good deal depends, of course, on the question whether the industry earns more than a normal return on its investment by virtue of the oligopolistic nature of the market. If the industry is earning only moderate returns, then the important question is the extent to which prices could be reduced over the cycle as a whole by establishing a different form of competition.

It should again be emphasized that the argument of the previous paragraph relates only to the effects of an isolated change in one industry, since it proceeds upon the assumption that the general business cycle is not significantly affected by the establishment of cyclical price flexibility in any one industry. Whether it is equally valid when applied to the economy as a whole is still a major controversial issue. Some view cyclical price rigidity as the major factor in depressions.[12] Others, on the other hand, contend that cyclical price rigidity exercises a stabilizing influence during both upswings and downswings.[13] A definitive answer to this problem is not yet at hand.

[12] See, for instance, Professor Viner's statement that "in the absence of price-rigidities substantial fluctuations in this ratio [of employed to employable resources] are inconceivable." Jacob Viner, "Business Cycle Theory—Can Depressions Be Tempered or Avoided," *Lectures in Current Economic Problems*, U. S. Department of Agriculture, Graduate School, November 1936, pp. 31–45.

[13] See Hansen, *op. cit.*; J. R. Hicks, *Value and Capital*, Oxford, 1939, especially Chapters XX and XXI; and the large body of Keynesian literature.

THE NATURE OF THE DEMAND FOR STEEL*

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In discussion of pricing policy and the trade cycle, a significant controversy has in recent years developed over the problem of price flexibility. For the most part the argument has been concerned with the question of price flexibility for the economy as a whole. In numerous instances, however, the social desirability of price flexibility has been debated even for rather narrow sectors of the economy, other parts considered as data.

One of the sectors whose pricing behavior very frequently has been pointed to in this connection is the steel industry. Some proponents of price flexibility have asserted that institutional changes in the steel market in the direction of greater price flexibility would significantly aid in stabilizing employment without bankrupting the industry. Opponents have countered with the statement that the greater price flexibility at best would bring about little improvement and might conceivably increase instability.

The contentions of both of these groups are based in part upon assumptions with respect to the short-period price elasticity of demand for steel.

This paper is a summary of five research reports whose major concern was to cast some light on the nature and importance of steel price changes with respect to cyclical variations in steel output. These reports were written under the general supervision of Dr. T. O. Yntema by members of the Special Economic Research Section of the United States Steel Corporation. The papers were presented and discussed at hearings of the Temporary National Economic Committee in January 1940, and have been published separately by the Corporation as the first five pamphlets of volume 1 of its *T.N.E.C. Papers.*

I cannot here consider the arguments or the data of these papers in detail. Rather I shall attempt to point to what I believe the authors considered their main arguments and findings.

At the outset it should be made clear that the authors of these five papers did not intend to, and did not discuss the following:

(1) The long period elasticity of demand for steel (although some conclusions can be drawn by implication).

(2) The so-called "cross elasticity" of demand for an *individual*

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940, in a session joint with the Econometric Society.

steel producer. The discussion was concerned with demand for the output of the industry as a whole.

(3) Price flexibility for the economy as a whole. That part of the economy outside the steel industry was considered as data.

Before considering the arguments presented in these several analyses of demand, we need a few definitions and a little algebra.

Definitions. (i) The term *steel* should be understood to mean what is generally classified as *finished* steel as sold by the steel industry to those outside the industry.

(ii) The *steel industry* is the steel-works and rolling mills industry.

(iii) A *product-made-from-steel* is any product one of whose raw materials is steel sold by the steel industry.

Let

$S(t)$ denote the time series of the (time) rate of domestic steel sales—i.e., orders (in physical units),

$\pi(t)$ the time series of the price of steel,

$Q(t)$ the time series of the (time) rate of output of products-made-from-steel (in physical units),

$T(t)$ the time series of the number of physical units of steel consumed per unit of output of products-made-from-steel,

$P(t)$ the time series of the price of products-made-from-steel,

$I(t)$ the time series of the (time) rate of increase of steel inventories in the hands of steel buyers (producers of products-made-from-steel).

Then the following relation is obviously true:

$$S(t) = Q(t) \times T(t) + I(t).$$

Let us denote by the symbol E_{yx} the (partial) elasticity of some variable $y(t)$ with respect to another variable $x(t)$, other factors determining $y(t)$ remaining unchanged, except as they are caused to change by changes in $x(t)$. From the above relation we obtain the basic elasticity relation:

$$E_{S\pi} = \left[1 - \frac{I(t)}{S(t)}\right] (E_{QP} \times E_{P\pi} + E_{T\pi}) + \frac{I(t)}{S(t)} \times E_{I\pi}.$$

The magnitude of these elasticities varies not only in trend and cycle, but also with the length of the period during which steel buyers and buyers of products-made-from-steel make adjustments to the change in $\pi(t)$ and the resulting change in $P(t)$. Only short adjustment period elasticities were analyzed in detail. The study of long period elasticities is more refractory.

In measuring these elasticities three complementary approaches were used:

(A) The "substitution" method,

(B) Multiple correlation analysis of time series,

(C) What Professor Tinbergen calls the "common sense" approach.

The Substitution Method. The argument used in the analysis of the demand for steel by the automobile industry (J. L. Mosak), and by the railroad and container industries (M. R. Segal) is for the most part that of the substitution method.

This method is concerned with elasticities of "run" only long enough to eliminate the price speculation elasticity. In this case $E_{I_\tau}=0$.

Thus the elasticity relation becomes

$$E_{S_\tau} = \left[1 - \frac{I(t)}{S(t)}\right](E_{QP}E_{P_\tau} + E_{T_\tau}).$$

The method then assumes that

(a) $\dfrac{I(t)}{S(t)}$ is ordinarily quite small so that

$\left[1 - \dfrac{I(t)}{S(t)}\right]$ can be taken as close to unity,

(b) $E_{P_\tau} \simeq R$,

where $R=\dfrac{\pi T}{P}$ is the cost of steel per dollar value of product-made-from-steel. That E_{P_τ} is not much greater than R is certainly a reasonable first assumption.

Furthermore, it seemed reasonable to suppose on *a priori* grounds that for such short adjustment periods E_{T_τ} would be negligible. Graphic correlation analysis in the auto and container studies gave results consistent with this hypothesis. With these assumptions the elasticity relations become

$$E_{S_\tau} \simeq E_{QP}E_{P_\tau} \simeq E_{QP}R.$$

For automobiles R has recently approximated 0.15. Roos and von Szeliski's study of automobile demand yielded -2.50 as a maximum estimate for E_{QP}. Thus for the automobile industry

$$E_{S_\tau} \simeq -0.15 \times 2.50 = -0.375,$$

which is probably high (numerically) rather than low.

For the container—canned goods—industry R varies for typical canned goods up to a maximum of around 0.25; 0.15 is probably a fairer figure for R for the industry as a whole. Estimates of E_{QP} were not made, but on the basis of various studies of the demand for food, it did not seem reasonable that E_{QP} could be as great numerically as 3.0 or 4.0. Therefore, it is very doubtful if E_{S_π} is numerically greater than 1.0 for canned goods.

The analysis of the railroad industry's demand for steel is more complex for:

(1) The railroads do not sell an actual physical product-made-from-steel, but services,

(2) Their demand for steel is almost wholly replacement demand.

Consider the products-made-from-steel in this instance as rails-laid, locomotives and other rolling stock, etc. For the short run it is reasonable to assume for these products that their respective $E_{T_\pi} \backsimeq 0$. The effect of steel price variations on the demand for steel will thus depend upon their effects on:

(1) Railroad costs, hence railroad rates, and ultimately railroad traffic,

(2) The allocation of replacement purchases, given total purchases over the cycle as a whole.

The ratio of steel outlays to total railroad revenues is very small, averaging about 5 per cent over the period 1922–1938. Wherefore, railroad costs, and hence rates would at best be little affected by steel price changes. This insensitivity is enhanced by present institutional arrangements with respect to rate-making. So unimportant are steel expenditures in total railroad outlays that it is doubtful if steel price changes are even considered in rate-making. The elasticity of demand for railroad services is certainly not high enough to make steel prices of more than negligible importance in determining rail traffic.

For all practical purposes, the railroads' total demand for steel for the cycle as a whole can, therefore, be taken as independent of steel prices. However, it is conceivable that the time allocation of replacement purchases is sensitive to steel price changes. The railroads might, perhaps, profitably follow a cyclical policy of making replacements during the cyclical low of steel prices.

There is practically no evidence that the railroads have followed such a policy in the past. The decisions required are apparently of longer run than the railroads have been willing to make. When traffic and income are low, replacement pressure is also low, and the replacements are postponed. When traffic is high, replacements become necessary almost

without regard to price. Thus in the present institutional setting, the elasticity of demand for steel by the railroads is probably very small.

Some other values of R for various products-made-from-steel follow:

	Per cent
Reinforced concrete road	0.7
Electric refrigerator	3.4
Four room frame house	4.3
Apartment house	5.9
Low priced farm implements	22.3

In the majority of cases where evidence was available, the value of the steel cost ratio, R, was less than 0.25, and in many cases less than 0.10. With the exception of the Roos-von Szeliski figures on the elasticity of demand for automobiles, values of the E_{QP} were not available. However, it seems doubtful if these elasticities were, except for insignificant cases, in excess of 2.0 or 3.0; even smaller figures seem more reasonable. Most products-made-from-steel are durable goods, as the studies emphasized, and on *a priori* grounds it is reasonable to expect this category of goods to have small price elasticities.

The Multiple Correlation Analysis. In the multiple correlation analysis an attempt was made to get an over-all picture of the demand for steel. Annual data for the years 1922–1938 were used with trends eliminated in the regressions. Thus, the period of "run" of the resulting demand regressions was short—probably not exceeding two years. In the absence of an adequate dynamic demand model, linear multiple regressions were fitted. Graphical analysis of the data failed to indicate clearly what other hypotheses as to the form of the regression would have been more appropriate.

Three estimates of steel sales were used as dependent variables:

(1) Steel bookings—that is, new orders of steel,

(2) Steel shipments,

(3) Total steel ingot production.

The first two series were estimated by multiplying the corresponding United States Steel series by the ratio of the steel industry's ingot production to that of the corporation.

Two series of composite steel prices were used alternately in the analysis:

(1) The *Iron Age* composite price of finished steel,

(2) The United States Steel's composite mill-net yield index. Both price series gave approximately the same results.

The other independent variables included one or more of the following variables:

(1) Supernumerary national income,
(2) Corporation profits,
(3) The Federal Reserve Board index of industrial production (with the iron and steel component removed),
(4) Link relatives of the composite price of steel,
(5) Link relatives of supernumerary income,
(6) Time-trend.

The multiple correlations, as might be expected, were all very high; the smallest one was above 0.90. The gross inter-correlations between the steel price series and the other independent variables in any one of the regressions were all low, the highest one being 0.74 (between the mill-net index and corporation profits).

Although the elasticities varied considerably from regression to regression they were consistent in being numerically less than unity. Only a small percentage of the variation in steel sales was accounted for by steel price variations.

The Common-Sense Method. The third approach used was the common-sense or literary method characteristic of most current surveys of business conditions. Week to week fluctuations in steel sales over the four years—1936 through 1939—were studied by this method. This period was chosen both because it was recent, and because it included substantial price fluctuations and great variations in steel sales.

The arguments of this analysis are so detailed that I can do little more here than refer you to the paper itself and summarize its findings. Reasoning from a study of several steel industry and steel consumers trade journals and from a "common-sense" correlation of well over 100 relevant economic time series, it was concluded that the price elasticity for adjustment periods of 6 to 8 months or less was very small, and for very short periods probably positive rather than negative. Changes in the level of steel buying over this period could, for the most part, be explained by:

(1) The volume of steel inventory accumulated by consumers in the recent past,
(2) *Expected* steel prices,
(3) The current and anticipated level of general business activity,
(4) The length of time required to fill new orders of steel.

The evidence indicated that price flexibility had perverse short-run effects in this period. Price advances generated expectations of further price advances, forward buying, and over-accumulation of inventories. Price declines had the contrary effects. The importance of price changes on price anticipations has, I believe, important implications for short-run price flexibility theory.

ROBERT EMMET CHADDOCK, 1879–1940

To a greater extent than many members may realize, the American Statistical Association owes its present vigorous condition to Robert E. Chaddock. In 1917 he accepted the office of Secretary-Treasurer of the Association and for seven years gave of his time and energy with unlimited generosity. The Association was sorely in need of firm guidance in 1917 and, with the help of Mrs. Chaddock, he instilled new life into the organization. Terminating his work as Secretary-Treasurer in 1924 he was elected President of the Association in 1925. In his presidential address[1] "The Function of Statistics in Undergraduate Training" he said:

> My thesis is that the undergraduate majoring in the social sciences must have special training in the inductive scientific method applied to these fields and that he should have it early in his work as a *fundamental educational equipment.* A course in elementary statistical methods should be given, as laboratory courses are now given to beginners in the physical sciences. This course would bring students into intelligent contact with the facts of our social, economic and political life, an increasing number of which are expressed in quantitative form; it would place emphasis upon accuracy of information, upon valid methods of analysis and comparison, and upon caution in generalizing; and it would aid in describing the situations of every-day life without premature theorizing.
>
> . . . The use of the inductive method requires rigorous training in scientific procedures. We are permitting the undergraduate in the social sciences to become lost in a wilderness of concrete data and badly supported general statements without showing him how to find his own way about. He has not yet acquired the wariness and wisdom that scientific training gives, and he is lured constantly on false trails, due to the bias of his hopes and enthusiasms. We have an obligation of first importance to remedy this situation. The elements of statistical method given as a fundamental discipline to undergraduates will furnish them with the broad foundations for scientific work and will cultivate their critical judgment of facts and explanations offered by others.
>
> For this purpose statistics should not be conceived in any narrow or professional sense. It is not merely technique or a branch of mathematical science. It is concerned with a body of principles and methods developed to guide the student in assembling and in handling quantitative data. It is a point of view, a method of attack. It involves measurements, countings and estimates, a careful record, intelligent groupings, discriminating analysis, logical comparisons, clear presentations, and cautious weighing of evidence. There are principles and procedures common to many different fields of work. *These constitute the unity of the subject.* We can leave the special methods to be developed and applied to particular problems by professional and research workers.

[1] This Journal, March 1926, p. 1.

In 1908, as a young man, he had already begun a career of unselfish service as he worked with the boy's club of the Union Settlement in New York City. Even then, Robert E. Chaddock had that gracious manner and that willingness to give unstintingly of his own time to help others, which later endeared him to so many of his students and colleagues. His service at Union Settlement bore its own reward for at Henry Street Settlement was Rose A. Fallbush. They met, through their settlement work, and two years later Miss Fallbush became Mrs. Chaddock.

Robert Emmet Chaddock was born April 16, 1879, at Minerva, Ohio, where he attended grade and high school. His father was a farmer and the future authority on population learned about the practical side of food production. He graduated from Wooster College in 1900 and taught there from 1900 to 1905. Wooster honored him with an LL.D. in 1929. Leaving Wooster he came to Columbia and enrolled as a graduate student under the late Professor Franklin H. Giddings. He received his M.A. degree in 1906, was University Fellow in Sociology 1906–08, and received his Ph.D. degree in 1908. He was Instructor in Economics at Columbia 1907–09. One year after receiving his doctorate he joined the staff of the Wharton School of the University of Pennsylvania as Assistant Professor of Economics and Statistics, where he remained until 1911. In 1911 he returned to Columbia as Assistant Professor of Statistics to carry on and further develop the work originally begun by Richmond Mayo-Smith. In his later years Chaddock bore a remarkable resemblance to Mayo-Smith. In 1912 he was promoted to Associate Professor of Statistics and in 1922 he was made Professor of Statistics. His interests were primarily in the fields of population and vital statistics and he was therefore a member of the Department of Social Science. He served as chairman of the department for some months immediately preceding his death, which occurred October 21, 1940.

Robert E. Chaddock's professional activities were national and international in scope and led to developments of outstanding importance. From 1925 until his death he was a member of the Joint Advisory Committee to the Director of the Census. Growing out of the work of this committee, and under its authority, recommendations were presented to the Director of the Census which resulted in the reorganization of the Division of Vital Statistics in 1935. In 1937 he was elected chairman of this advisory committee and served faithfully to assist in planning the 1940 census.

From 1933 to 1936 he was a member of the Committee on Government Statistics and Informational Services, which was jointly set up by the American Statistical Association and the Social Science Research Council. The activity of this committee resulted in the formation of the Central Statistical Board, now the Division of Statistical Standards of the Bureau of the Budget. Recommendations of the Committee have resulted in many improvements in government statistics.

In July 1928 there was held at Paris an International Conference on Population. Professor Chaddock was a delegate to this conference representing the Social Science Research Council. The purpose of the conference was to organize the International Union for the Scientific Study of Population Problems. At the time of his death he was a member of the American Committee of this International Union.

He was one of the founders of the Cities Census Committee which, under the leadership of the late Dr. Walter Laidlaw, developed the "census tract" unit for enumeration and tabulation of population and other types of data in New York City. Following the lead of New York many other cities have adopted the "census tract" idea. The functions of this committee are now continued under the Welfare Council of New York City. At the time of its formation Professor Chaddock was consultant to the Research Bureau of the Welfare Council and at the time of his death was chairman of its Research Committee and a member of the Executive Committee. He was also sometime consultant statistician of the Commonwealth Fund in its Child Health Demonstration and member of the Advisory Council of the Milbank Memorial Fund. He was a member of the Committee on Research in Medical Economics from its organization, and at the time of his death was vice-chairman of the Committee and a member of the editorial board of the quarterly journal *Medical Care* of which the Committee is sponsor.

Professor Chaddock's best known publication was "Principles and Methods of Statistics" (1925), a leading textbook on statistics. He was at work on a revision of this volume at the time of his death. He was also author or joint author of numerous books, reports and articles on economic, sociological, and statistical topics.

In addition to being a Fellow and former President of the American Statistical Association he was also a Fellow of the American Public Health Association, and of the Population Association of America. He was a member of the International Statistical Institute, the American Sociological Society, Phi Beta Kappa, and the Century Club (New York).

Those of us who knew Robert E. Chaddock either as instructor or colleague, or both, will think of him not so much as guiding spirit of the American Statistical Association during critical times, not so much as outstanding authority on population and vital statistics whose advice was highly valued and often sought, but rather as patient teacher, helpful and kind, who was always willing to take his time, busy though he might be, to assist and advise any of those who turned to him for help. A host of friends in diverse fields will miss and long remember this kind and gentle councillor.

FREDERICK E. CROXTON

Columbia University

RAYMOND PEARL, 1879–1940

Biographical sketches of Raymond Pearl have appeared in a number of journals since his death on November 17, 1940. Most of these have outlined the important facts of his life, the titles of his books, and the several fields of investigation in which he worked. The readers of this Journal are undoubtedly familiar with those details so that a further recital of them here does not seem essential. They have been excellently summarized by Professor Lowell J. Reed in a recent issue of *Science*.[1]

Raymond Pearl's preoccupation was the biology of man. An evaluation of his work must take into account the point of view from which he saw that field. The task he assumed was the coordination of the several aspects of the investigation of man: the physiological, the medical, the anthropological, the genetic, the social and the ethnological, to name a few. In seeking to bring the fruits of all these modes of investigation into a broad outline of the life history of man, he found a solution in the quantitative approach. He was among the first, and one of the most influential, of those who fostered the statistical approach to the study of man.

In this large view which he developed with remarkable competence and keen insight, he finally came to center his attention on certain particular phases of the life history of man which were not only of first importance but in which his own special talents could be most productive. If the foregoing is a correct evaluation of what the study of human biology meant to Dr. Pearl, it was fitting and perhaps inevitable that he should have concentrated his later interests on fertility and population, and related fields of investigation.

Dr. Pearl was one of those most largely responsible for the high quality of present-day American research in population. His was the most active part in the formation of the International Union for the Scientific Investigation of Population, of which he was the first president and out of which grew the present Population Association of America.

He undertook the investigation of population with his characteristic broad outlook that encompassed many and varied approaches. His work during the last and most significant period of his career, at the Johns Hopkins University School of Hygiene and Public Health, from 1918 until his death, is outlined by the subjects of his published volumes during that time. These titles attest the width of his view: *The Biology*

[1] Vol. 92, No. 2400, December 27, 1940, p. 595.

of Death (1922); *Studies in Biology* (1924); *The Biology of Population Growth* (1925); *Alcohol and Longevity* (1926); *The Rate of Living* (1928); *Constitution and Health* (1933); *The Ancestry of the Long-Lived* (co-author, Ruth D. Pearl, his daughter) (1934); *The Natural History of Population* (1939).

Each of these works was the resultant of a vast quantity of compilation and analysis. Each is characterized by boldness, novelty, and freshness of thought; and by a unique, polished and engaging style. Primarily, however, each was provocative and stimulating to a wide audience of varied interests.

Among his always crowded, busy, and productive days, Dr. Pearl was able to find time for other interests and activities that set him apart as a most remarkable personality. His capacity for enjoying life was unusual, and manifested itself in a straightforwardness and simplicity of devotion to his family and home and friends. To Dr. Pearl, enjoyment meant whole-hearted participation, and this is best exemplified in his relish of music. He was a guiding spirit in two amateur musical groups in Baltimore, which played for the sole purpose of amusing themselves. Although he had some ability with most wind instruments, his principle love in the later years of his life was the difficult French horn, from the playing of which he derived considerable delight.

At no time was the richness of his personality more evident than when he undertook the rôle of genial host. In the quiet and dignity of his home, he loved to entertain his friends, his students, and his colleagues. In such quiet hours of companionship, the depth of his thought and of his knowledge transferred to those who sat around him a measure of his own enlightenment and inspiration.

HALBERT L. DUNN, M.D.

A CORRECTION

Footnote 8 of the article, "The Effects of Federal Revenue Acts of 1938, 1939, and 1940 on the Realization of Gains and Losses on Securities" appearing in the December 1940 issue of this Journal, p. 608, states that 8 per cent is the maximum rate applicable to net capital gains under the income tax law of New York State. This was true when the basis of the article and illustrative tables were prepared. Since that time the maximum New York State rate has been reduced to 3½ per cent. This change in no way affects the theory and formulae used in the article; but the illustrative tables do not indicate precisely the present situation for New York State taxpayers. The sum of the appropriate federal and state rates should be used in practical application of the formulae.

Q. Forrest Walker

PROCEEDINGS

102ND ANNUAL MEETING

STEVENS HOTEL, CHICAGO

PROGRAM

Thursday, December 26, 1940

—2:30 P.M.—

PROBLEMS OF BANK CAPITAL
Chairman: Donald S. Thompson, Federal Deposit Insurance Corporation
Determination of Adequacy of Bank Capital
Homer Jones, Federal Deposit Insurance Corporation
Sources of Capital Funds
Roland Robinson, Board of Governors of the Federal Reserve System
Bank Capital and Credit Expansion
Roy Reierson, Bankers Trust Company
Discussion: Joseph E. Loftus, The Johns Hopkins University
Walter Lichtenstein, First National Bank, Chicago

THE ESTIMATION OF ANIMAL POPULATIONS
(Arranged by the Biometrics Section. With the Ecological Society of America)
Chairman: V. E. Shelford, University of Illinois
The Estimation of Insect Population over Areas of the Magnitude of a Township
Geoffrey Beall, Dominion Entomological Laboratory
The Measurement of Fish Populations in Inland Waters
David H. Thompson, Illinois State Natural History Survey
Methods for Estimating the Population of Mammals
L. R. Dice, University of Michigan
Cooperation of Statisticians and Ecologists on Problems and Methods of Mutual Interest
Thomas Park, University of Chicago
Discussion: A. G. Clark, Colorado State College
C. P. Winsor, Iowa State College
C. C. Craig, University of Michigan

Thursday, December 26, 1940

—2:30 P.M.—

STATISTICAL RESEARCH IN THE FIELD OF PUBLIC WELFARE

(Arranged by the Joint Committee on Relief Statistics)
Chairman: Anne E. Geddes, Social Security Board
The Food Stamp Plan and Certain Other Programs as They Affect Public Assistance Statistics
E. E. Forebee, Illinois State Emergency Relief Commission
Depressed Areas—A Blind Alley of Relief
John N. Webb and Malcolm Brown, Work Projects Administration
Research in Administration of Public Assistance
Benjamin Wood, Wisconsin State Department of Public Welfare
Discussion: Norman Lazarus, Illinois State Department of Public Welfare
Don Trauger, Iowa State Board of Social Welfare

—8:00 P.M.—

MEASUREMENT OF MARKETING EFFICIENCY

(With the American Marketing Association)
Chairman: Theodore N. Beckman, Ohio State University
Criteria of Economic and Marketing Efficiency
Nathanael H. Engle, Advisory Commission to the Council of National Defense
Efficiency within the Marketing Structure
Roland S. Vaile, University of Minnesota
A Critical Analysis of Recent Literature Dealing with Marketing Efficiency
Charles F. Phillips, Colgate University
Discussion: Wroe Alderson, Curtis Publishing Company
John Albright, Bureau of the Census
H. W. Huegy, University of Illinois

SOME PROBLEMS OF NATIONAL DEFENSE

Chairman: W. Leonard Crum, Harvard University
The Problem of Statistical Control—Military Aspects
Richard O. Lang, Office of the Assistant Secretary of War
The Problems of Statistical Control—Economic Aspects
Robert R. Nathan, Advisory Commission to the Council of National Defense
Business Approaches to Rearmament Production Control
Theodore H. Brown, Harvard University
Housing in Relation to National Defense
Samuel J. Dennis, Advisory Commission to the Council of National Defense
Measuring the Labor Requirements
Stephen M. DuBrul, General Motors Corporation
Labor Requirements Estimated for the Aircraft Industry under the National Defense Program
Donald H. Davenport, Bureau of Labor Statistics

Friday, December 27, 1940

—10:00 A.M.—

Administration of the Wage-Hour Law—Needed Improvements in Information

(With the American Association for Labor Legislation)
Chairman: Edith Abbott, University of Chicago

Administrative Review and Proposed Improvements
Thomas Holland, U. S. Department of Labor

A State View of Needed Improvements
Anne S. Davis, Illinois State Department of Labor

Labor's View of Wage-Hour Law Administration
Abraham Plotkin, International Ladies Garment Workers Union

Discussion: Mary Anderson, Women's Bureau
Agnes Nestor, Women's Trade Union League

Contributed Papers

(Arranged by the Biometrics Section)
Chairman: George W. Snedecor, Iowa State College

The Median as a Forecast Value
Alan E. Treloar, University of Minnesota

Variations in the Number of Febrile Patients with Pulmonary Tuberculosis
Alvin Mayne, University of Illinois Medical College, and John S. Howe, Medical College of Virginia

On the Mortality in Husbands and Wives
Antonio Ciocco, National Institute of Health

On the Use of the Chi-square Test with Small Expectations
H. C. Fryer, Kansas State College of Agriculture and Applied Science

Determination of Depth Dose of X rays from Data on the Growth of Lettuce Seedlings
C. I. Bliss, Connecticut Agricultural Experiment Station

Census Data—Their Form of Presentation

Chairman: Howard Whipple Green, Cleveland Health Council

Problems Concerning the Availability of Census Data
Halbert L. Dunn, M.D., Bureau of the Census

The Form in Which Statistics Should Be Presented To Be Most Easily Used by the Statistician
Lester S. Kellogg, Advisory Commission to the Council of National Defense

Statistics Requested from a Business Library
Rose L. Vormelker, Cleveland Public Library

How the Consumer of Statistics Likes the Facts Presented
John W. Love, *The Cleveland Press*

Friday, December 27, 1940

—10:00 A.M.—

STATISTICAL ANALYSIS OF THE DEMAND FOR STEEL
(With the Econometric Society)
Chairman: Rufus S. Tucker, General Motors Corporation
Nature of the Demand for Steel
H. Gregg Lewis, University of Chicago
Cost Functions in the Steel Industry
Mordecai Ezekiel and Kathryn H. Wylie, U. S. Department of Agriculture
Theoretical Implication of the Analysis
Jacob Mosak, University of Chicago
Discussion: Gerhard Tintner, Iowa State College

—12:30 P.M.—

LUNCHEON MEETING, CENSUS TRACT CONFERENCE
(Arranged by the Committee on Census Enumeration Areas)
Chairman: Howard Whipple Green, Cleveland Health Council

—2:30 P.M.—

STANDARD CENSUS TRACT TABULATIONS FOR CENSUS TRACT CITIES
(Arranged by the Committee on Census Enumeration Areas, continuation of the luncheon meeting)
Chairman: Howard Whipple Green, Cleveland Health Council
Proposed Census Tract Tables from 1940 Census Data
Philip M. Hauser, Bureau of the Census
Census Data by Blocks for Larger Cities
Howard G. Brunsman, Bureau of the Census
Significance of Block Data
Ernest M. Fisher, Member of the Committee
Discussion of developments in the use of census tract data, by the representatives of ten cities

STATISTICAL PHASES OF THE PROBLEM OF UNEMPLOYMENT
(With the American Association for Labor Legislation)
Chairman: William A. Berridge, Metropolitan Life Insurance Company
What Constitutes Optimum Employment?
E. Gordon Keith, University of Pennsylvania
Meaning of Unemployment Estimates
Aryness Joy, Bureau of Labor Statistics
Dynamics of the Labor Market
Howard B. Myers, Work Projects Administration
Cyclical Fluctuations in the Demand for Labor
Spurgeon Bell, National Resources Planning Board, Executive Office of the President
Relation of Defense Expenditures to Employment and National Income
Louis H. Bean, Bureau of Agricultural Economics

Friday, December 27, 1940

—2:30 P.M.—

SIGNIFICANCE AND LIMITATIONS OF OUR MAJOR PRICE INDEXES

Chairman: Stuart A. Rice, Bureau of the Budget, Executive Office of the President

Wholesale Price Indexes
Francis E. McIntyre, Indiana University

Cost of Living Indexes
Robert A. Sayre, National Industrial Conference Board

Indexes of Prices Farmers Pay
Joel Dean, University of Chicago

Price Indexes as Viewed from the Standpoint of the National Defense Program
Martin Taitel, Advisory Commission to the Council of National Defense

Discussion: Lester S. Kellogg, Advisory Commission to the Council of National Defense
Ruth W. Ayres, Advisory Commission to the Council of National Defense

ROUND TABLE ON FINANCING THE DEFENSE PROGRAM

Chairman: Robert R. Nathan, Advisory Commission to the Council of National Defense

Discussion: Milton Gilbert, U. S. Department of Commerce
Albert Gailord Hart, Iowa State College
Richard A. Musgrave, Harvard University
Murray Shields, Irving Trust Company
Homer Jones, Federal Deposit Insurance Corporation

ANALYSIS OF VARIANCE

(With the Institute of Mathematical Statistics and the Econometric Society)
Chairman: Paul R. Rider, Washington University

The Relation between the Design of an Experiment and the Analysis of Variance
A. E. Brandt, U. S. Department of Agriculture

The Underlying Principles of the Analysis of Variance and Associated Tests of Significance
Churchill Eisenhart, University of Wisconsin

The Applications of the Analysis of Variance to Non-Orthogonal Data
W. G. Cochran, Iowa State College

Discussion: Gertrude M. Cox, North Carolina State College
John F. Kenney, University of Wisconsin Extension Division, Milwaukee
W. Edwards Deming, Bureau of the Census

Friday, December 27, 1940

—8:00 P.M.—

Presidential Addresses

(With the American Sociological Society)

Chairman: William F. Ogburn, University of Chicago

An Inquiry into the Nature and Causes of Statisticians

F. Leslie Hayford, New York City, President of the American Statistical Association

Some Reflections on Sociology During a Crisis

Robert M. MacIver, Columbia University, President of the American Sociological Society

Saturday, December 28, 1940

—9:00 A.M.—

Annual Business Meeting, Report and Election of Officers

—10:00 A.M.—

The Financing of Business

Chairman: Neil H. Jacoby, University of Chicago

Liquidity, Debts and Equities

Albert Gailord Hart, Iowa State College

Sources and Uses of Corporation Funds

Arthur Hersey, Board of Governors of the Federal Reserve System

Financing of Business Through Bank Term Loans

Leo Achtsohin, Society for Savings

Discussion: Charles Merwin, National Bureau of Economic Research
Raymond Hengren, Securities and Exchange Commission

Collection and Use of Statistics for Quality Control in National Defense Industries

(With the Institute of Mathematical Statistics)

Chairman: C. W. Gates, Western Electric Company

Report on the Quality Control Program of the American Standards Association

Prepared by the Committee and presented by C. S. Barrott

Sample Verification in the Administration of the Population Census

W. Edwards Deming, Bureau of the Census

The Importance of the Statistical Viewpoint in High Production Manufacturing

P. L. Alger, General Electric Company, presented by Churchill Eisenhart, University of Wisconsin

Initiation of Statistical Methods for Quality Control in Industry

Leslie E. Simon, Ballistic Research Laboratory, Aberdeen Proving Ground

Discussion

Saturday, December 28, 1940

—10:00 A.M.—

THE ADEQUACY OF PRESENT STATISTICAL DATA ON OCCUPATIONS, EMPLOYMENT, AND PUBLIC ASSISTANCE IN THE UNITED STATES

Chairman: Frederick F. Stephan, Cornell University

Occupational Statistics

Gladys L. Palmer, University of Pennsylvania

Employment Statistics

Arthur H. Reede, Pennsylvania State College

Public Assistance Statistics

Herman M. Somers, National Resources Planning Board, Executive Office of the President

Discussion: Sophia M. Robison, New York City

PRINCIPLES AND PROCEDURES FOR PUTTING ACROSS BUSINESS-STATISTICS REPORTS TO EXECUTIVES

Chairman: Seymour L. Andrew, American Telephone and Telegraph Company

John W. Scoville, Chrysler Corporation

Victor H. Pelz, General Foods Sales Company

John W. Boatwright, Standard Oil Company of Indiana

Louis D. H. Weld, McCann-Erickson, Incorporated

Henry B. Arthur, Swift and Company

Robert B. King, American Telephone and Telegraph Company

—2:30 P.M.—

RECENT DEVELOPMENTS IN CONSTRUCTING INDEX NUMBERS OF INDUSTRIAL OUTPUT, INVENTORIES, SHIPMENTS, AND ORDERS

Chairman: Donald S. Tucker, Massachusetts Institute of Technology

Speakers:

Maxwell R. Conklin, Board of Governors of the Federal Reserve System

Clyde L. Rogers, National Industrial Conference Board

Milton Gilbert, U. S. Department of Commerce

Discussion: Charles A. R. Wardwell, Northwestern University

Olin W. Blackett, University of Michigan

W. Leonard Crum, Harvard University

H. LeBrec Micoleau, General Motors Corporation

COLLECTION AND USE OF STATISTICS FOR QUALITY CONTROL IN NATIONAL DEFENSE INDUSTRIES

(With the Institute of Mathematical Statistics)

Chairman: John Johnston, United States Steel Corporation

The Place of Statistical Analysis in Ferrous Metallurgy

E. M. Schrock, Jones and Laughlin Steel Corporation

Statistical Methods in the Production and Inspection of Cast Iron Pipe

J. T. MacKenzie, American Cast Iron Pipe Company

Applications of Statistical Methods to Metallurgy

R. B. Mears, Aluminum Company of America

Discussion

Saturday, December 28, 1940

—3:00 P.M.—

NEW FEATURES OF THE 1940 POPULATION CENSUS

(With the American Sociological Society. Arranged by representatives of the Bureau of the Census)

Chairman: Clark Tibbitts, University of Michigan

New Features of the 1940 Population Census
Leon E. Truesdell

General Population Statistics
Henry S. Shryock

Employment and Income Statistics
A. Ross Eckler

Occupation and Industry Statistics
Alba M. Edwards

Housing Statistics
Howard G. Brunsman

The Use of Sampling in the Census
Philip M. Hauser

—6:30 P.M.—

DINNER MEETING: THE BUSINESS OUTLOOK

Chairman: F. Leslie Hayford, President of the American Statistical Association

Lionel D. Edie, Lionel D. Edie & Company

James F. Hughes, Smith, Barney and Company

Melchior Palyi, Lecturer and Financial Advisor

Minutes of the Annual Business Meeting

The American Statistical Association convened for the 102nd annual business meeting at 9:00 A.M. Saturday, December 28, 1940, at the Stevens Hotel in Chicago, Illinois. President F. Leslie Hayford presided.

The minutes of the 101st annual business meeting were approved as published in the JOURNAL.[1]

The Secretary read the Annual Report of the Board of Directors.[2]

The report of the Committee on Fellows was read by its Chairman, Walter A. Shewhart. The Committee announced the election of the following Fellows: Joseph Berkson, Samuel A. Stouffer, Helen M. Walker, Samuel S. Wilks, and Theodore O. Yntema. President Hayford announced the appointment of Theodore H. Brown to the Committee on Fellows for the period ending at the annual meeting in 1945.

The report of the Nominating Committee was presented by Henry B. Arthur. The Secretary reported that he had received no nominations by petition. It was voted to instruct the Secretary to cast one ballot for the candidates presented by the Nominating Committee. The ballot was cast and the following officers and directors were elected:

President WINFIELD W. RIEFLER, Institute for Advanced Study

Vice-Presidents

Collection and Classification of Data, and Administration of Statistical Agencies
MEREDITH B. GIVENS, New York State Department of Labor

Statistical and Actuarial Methods and Technique, and the Teaching of Statistics
HAROLD HOTELLING, Columbia University

Facts and Methods Pertaining to Sociology, Social Welfare Problems, and Labor Statistics
HELEN R. JETER, Welfare Council of New York City[3]

Facts and Methods Related to Biometry, Vital Statistics, Psychology, and Education
DOUGLAS E. SCATES, Duke University

Facts and Methods Bearing upon Economics and Economic Theory
ROBERT R. NATHAN, Advisory Commission to the Council of National Defense

Facts and Methods Pertaining Primarily to Business
JOHN W. SCOVILLE, Chrysler Corporation

Facts and Methods Pertaining to Financial Institutions
ERNEST M. FISHER, American Bankers Association

[1] This JOURNAL, 35 (March 1940), 150.

[2] This JOURNAL, p. 132.

[3] Following the annual business meeting it was learned that Miss Jeter had resigned from the Welfare Council of New York City.

Facts and Methods Pertaining to Marketing
FREDERICK V. WAUGH, United States Department of Agriculture

Directors

(For the terms expiring at the Annual Meeting in 1943)
F. LESLIE HAYFORD, New York City
FREDERICK F. STEPHAN, Cornell University
(For the term expiring at the Annual Meeting in 1942)
LOWELL J. REED, The Johns Hopkins University
(For the term expiring at the Annual Meeting in 1941)
O. C. STINE, United States Department of Agriculture

Secretary-Treasurer

RICHARD L. FUNKHOUSER, American Statistical Association

The Secretary presented a recommendation of the Board of Directors for the amendment of By-Law 5. It was voted to amend the third paragraph of By-Law 5 to read as follows: "The fiscal year shall be the calendar year. The Treasurer shall make a detailed financial report to the Board of Directors within thirty days after the end of each fiscal year. The Treasurer's report shall be audited either by an Auditing Committee appointed by the President before the expiration of his term of office, or by a firm of independent public accountants selected by the Board of Directors. The report of the Auditing Committee or the independent public accountants, as the case may be, shall be published with the Treasurer's report in the JOURNAL."

The Secretary presented a recommendation of the Board of Directors that By-Law 2 be amended. It was voted to amend By-Law 2 by adding to the first sentence of the first paragraph the following phrase: " . . . provided, that the Board of Directors may establish a rate of annual dues of not less than $3.00 during the first three years of membership under such restrictions as the Board of Directors may deem to be in the best interests of the Association."

The meeting was adjourned.

R. L. FUNKHOUSER, *Secretary*

Report of the Board of Directors

The current year witnesses the inauguration of the second century of the active and useful life of our Association. Your officers believe that the record for the year gives evidence of our having made an appropriate beginning, not only by continuing the work launched during the years preceding but also by initiating plans for advancement along new lines. As the year draws to a close, we wish to present to the members of the American Statistical Association a brief summary of activities and accomplishments during 1940.

Before turning to the year's report, however, the Board of Directors wishes to take this occasion to record its deep sense of loss in the death on

November 17 of one of its valued and honored members and a past President of the Association, Professor Raymond Pearl. His leadership in the Association and in the statistical profession had a marked influence and will be sorely missed.

Committees: Early in the year the Board of Directors reexamined the committee structure of the Association, and adopted a policy of an annual review of the work of each committee by a member of the Board. The officers believe that this step will promote the more effective integration of the activities of the committees and will make for the steady improvement of those activities.

A number of new committees were established during the year. One of these was the Committee on Chapters, which has been actively engaged on a program to assist the chapters in securing prominent out-of-town members to address their meetings. Several chapters have already benefited and it is anticipated that the future holds great promise of further development. An Advisory Committee on the National Roster of Scientific and Specialized Personnel was established to render continuing professional advice on the statistical phases of the Roster referred to elsewhere in this report. On the invitation of the Librarian of Congress, a representative of the Association was appointed to the Advisory Committee of the Census Library Project, the purpose of which is to render technical advice to the staff of the Library of Congress in connection with their establishment of a complete and well-organized collection of census material from this and other countries.

The other committees of the Association have also made important contributions to the Association's work.

The Census Advisory Committee met on three occasions to review the progress of the Decennial Census of 1940 and to advise on the preparation of the regular reports and a series of special monographs. The Committee on Census Enumeration Areas has been active in the promotion of the use of census tract statistics from the 1940 Census.

The Joint Committee on Relief Statistics, sponsored by our Association and the American Public Welfare Association, continued to render valuable assistance both directly and through its subcommittees in the promotion of more comprehensive and reliable statistics on various phases of public assistance. It also published one number of its *Bulletin of Information for Relief Statisticians* and two additional papers on relief statistics.

The Joint Committee on Occupational Classification, sponsored by the American Statistical Association and the Division of Statistical Standards of the Bureau of the Budget, continued to advance the integration of occupational data collected by different statistical agencies and the improvement of the occupational classifications in current use. Through a subcommittee, attention was also given to the many technical questions arising as a result of shifts in occupations and the development of new occupational titles.

Through its representatives on the Social Science Research Council effective leadership was given to the extension of statistical applications in scien-

tific research in the social sciences. One of the members of the Board was the Association's representative at the Conference on Nomenclature held by the American Medical Association. Through its representative on the Sectional Committee on Standards for Graphic Presentation the Association participated in the preparation of standards for engineering and scientific graphs.

Thus we see that the Association, through its committees and representatives, has been alert to the responsibilities resting upon it for the improvement of statistics, statistical methods and professional personnel, not in one or two fields alone but in many and varied spheres of activity.

Chapters: During the year a chapter of the Association was established in Atlanta, Georgia, as a result of the affiliation of the Atlanta Statistical Association. Inquiries regarding possible affiliation were received from interested groups of statisticians in a number of other localities, and undoubtedly several of these will become chapters in the near future. This interest in our chapter work indicates the steady development of the Association as a society increasingly national in character.

The chapter activities in areas already organized gave evidence of continued vigor in the pursuit of their respective programs. In addition to their regular meetings, a number of the chapters have had committees at work on special assignments. Illustrative of these is the work of a committee of the Connecticut Chapter that has made a thorough-going appraisal of state statistical reports and drawn up recommendations for their improvement. The Columbus Chapter initiated a project looking to the improvement of the statistics of the state government of Ohio. Still other chapters, including those in Albany and Harrisburg, continued projects launched in earlier years.

Publications: The regular numbers of the JOURNAL and the *Bulletin* were printed during the year, and a number of noteworthy features marked the development of our publication program. The *Proceedings of the Centenary Celebration*, summarizing the Centenary programs at Boston in November and at Philadelphia in December, 1939, was published as a supplement to the March issue of the JOURNAL. Through the cooperation of the members the *Centenary Membership Directory* was prepared and printed as a supplement to the June issue of the JOURNAL. This was the first directory of the membership since 1935 and filled a pressing need among the officers and other members. It is anticipated that it will be supplemented by annual lists of the new members published in the JOURNAL or the *Bulletin*.[1]

Later in the year, the Board of Directors reviewed the policies relating to the publications of the Association and authorized important changes in the JOURNAL and the *Bulletin*. Your officers do not feel that the financial position of the Association warrants at this time any substantial enlargement in our publication program, but they believe that significant improvements can be effected by making the *Bulletin* the medium for reviewing current

[1] Subsequently the Board of Directors decided to omit the annual list of the new members, in order to effect desirable economies.

developments and for the informal discussion of statistical questions and by publishing it more frequently than heretofore. Accordingly, plans to accomplish this, beginning with 1941, have been carried to completion and were announced in the December issue of the *Bulletin*. The JOURNAL will be reserved for the more permanent contributions to statistical literature and for book reviews.

Through a grant of funds from the Rockefeller Foundation an *Index to the Journal of the American Statistical Association* was prepared during the year and is now in press. It covers the entire period from 1888 through 1939, and will be an immensely valuable guide to the wealth of information stored in the 34 volumes covered by the *Index*.

Advisory services on statistical personnel: The rapid growth of statistical agencies, both public and private, that has characterized the past decade has made increasingly important the development of efficient means for the recruitment of competent statistical personnel. During the past year the officers have been actively engaged in advancing this objective. Extensive advisory assistance was rendered to the officials responsible for the National Roster of Scientific and Specialized Personnel, in which statisticians are included. The purpose of the Roster is to establish a series of central files of competent professional personnel to facilitate the effective recruitment of skills essential to national defense. By taking part in this undertaking the Association has advanced and will continue to advance toward the goal of better statisticians in the Federal service, in recognition of the vital position they occupy in the defense program.

Membership and finances: The Association continues to grow in size and to gain financial strength. The statement of the Secretary indicates that we had a net increase of well over 200 members. The Treasurer's report shows that we are making progress toward the objective of offsetting the effect of the termination at the end of this year of the Rockefeller Foundation grant that has helped to support the Association's expanded activities during the past six years. The sum of $1,500 drawn during the year from the Centenary Sustaining Fund to supplement our regular income has made it possible for us to maintain the important work inaugurated in the past and to expand it into new channels.

Our resources do not yet permit us to undertake a good many activities that we should be carrying on. We believe, however, that the future holds out a reasonable prospect that the Association may continue to gain strength as it develops an increasingly effective program.

Outlook for the future: To some extent our view of the future is obscured by the consequences of armed conflict in various parts of the world. The uncertainty generated by that conflict, however, should reinforce rather than diminish our regard for the importance of trustworthy statistical information and our confidence in the increasingly vital part it will play in the orderly development of the social and economic life of mankind.

There is steadily growing evidence, it seems to us, of the need for timely,

accurate statistics, their economic collection, and their reliable analysis.

If this be so, the American Statistical Association has both a grave responsibility and a challenging opportunity to furnish the leadership in advancing the development of better statistics and improved statistical methods. Your officers believe that the Association is ready to assume that responsibility and to avail itself of that opportunity.

W. LEONARD CRUM
HALBERT L. DUNN
R. L. FUNKHOUSER
F. LESLIE HAYFORD
GEORGE O. MAY
WALTER W. STEWART
WILLARD L. THORP

Report of the Secretary

Most of the activities in which the Secretary was concerned during the year are included in the Report of the Board of Directors. However, it is customary for the Secretary to summarize the statistics about the membership of the Association. During 1940 the membership increased from 2,502 to 2,734, reflecting a net growth of 232 members. During the year 423 new members were elected and 42 members were reinstated. Eleven members died during the year, including four Fellows and one Life Member; 76 members resigned; the memberships of 140 were removed from the rolls for failure to pay dues, 29 of whom were reinstated before the end of the year.

Membership statement, December 31, 1940

Honorary members	16
Corporate members	4
Fellows	97
Regular members	2,617
Total membership	2,734

One Fellow was a Contributing Member during 1940. Two members became Life Members during the year, bringing the total number of Life Members to 37.

The death of the following members was recorded during the year: Robert E. Chaddock, Roland P. Falkner, Raymond Pearl, and Fred G. Tryon, *Fellows;* Mercer G. Evans, Joseph Froggatt, Max S. Handman, I. B. McCorkle, Joseph H. Prior, David B. Rushmore, and Arthur F. White, *Regular Members.*

R. L. FUNKHOUSER, *Secretary*

Report of the Treasurer

The calendar year 1940 marked the first year during which the Centenary Sustaining Fund was drawn upon to strengthen the financial position of the Association. The Board of Directors authorized the transfer of $1,500 from the Fund to the general budget, offsetting the decline of the same amount in the Rockefeller Foundation grant for general purposes. Thus, the Association benefited in 1940 from the successful effort of the preceding year, in connection with the celebration of our Centenary, to provide stronger financial support to our activities.

Our income from regular sources increased nearly $1,200 in comparison with 1939, reflecting an expansion of almost $1,700 in dues income offset by declines in a number of other items. The increased income from dues during the year was largely the outgrowth of the special effort during the Centenary period to interest new members in the Association.

The expenses incurred in connection with our regular program of activities increased by a little more than $500, owing principally to the extra expense associated with the change in the Secretary-Treasurer and the resulting overlap in employment. The cost of the Centenary celebration and the Centenary membership campaign in 1939, amounting to over $800, did not recur in 1940. However, we did publish the *Centenary Membership Directory* at a cost of about $700. This expense will not be repeated for a number of years. The work on the *Index to the Journal* involved an expense of nearly $1,600 in excess of that in 1939, but the cost in both years was met by a Rockefeller Foundation grant.

Excluding the cost of the *Centenary Membership Directory*, which represents a special publication prepared about every fifth year, the excess of expenses over income in 1940 would be less than $300. This represents a distinct improvement over 1939, even taking account of the extraordinary expenses in that year.

The balance sheet and other detailed financial statements, with comparative figures for 1939, are included in the Auditors' Report.

R. L. FUNKHOUSER, *Treasurer*

Report of the Auditors

To the Board of Directors of
American Statistical Association

We have examined the balance sheet of the American Statistical Association as at December 31, 1940 and the statements of income and surplus for the year then ended, have reviewed the accounting procedures of the Association and have examined or tested accounting records and other supporting evidence, by methods and to the extent we deemed appropriate.

The recorded cash receipts for the year were traced to the deposits shown on the bank statements and the amounts for dues and subscriptions were tested with the membership and subscription records. The paid checks and relative vouchers were inspected in support of the cash disbursements for the year. The cash balances and the securities owned as at December 31, 1940 were confirmed by inspection or by certificates obtained direct from the depositaries. We did not check the membership and subscription records in detail or make any independent verification of the inventory of old journals, the office records of which are based in part on data assembled in prior years, no recent physical inventory having been taken.

In our opinion, the accompanying balance sheet and related statements of income and surplus present fairly the position of the American Statistical Association at December 31, 1940 and the results of its operations for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

PRICE, WATERHOUSE & CO.

March 3, 1941

AMERICAN STATISTICAL ASSOCIATION

BALANCE SHEETS

Assets		December 31, 1940	December 31, 1939
Cash in bank and on hand		$ 2,399.36	$ 9,319.28
Accounts receivable		156.83	376.64
Investments:			
United States Savings Bonds, at redemption value		5,052.00	2,025.00
Stocks, at cost (at market quotations $4,158 and $4,934, respectively)		5,793.50	5,793.50
Inventory of old Journals, at approximate cost applied to salable quantities		1,791.75	1,754.20
Furniture and equipment, at cost less depreciation		627.07	699.49
		$15,820.51	$19,968.11
Liabilities			
Accounts payable		$ 245.91	$ 1,305.13
Special account—Allied Social Science Associations		398.33	298.54
The Rockefeller Foundation grant for the Index to the Journal:			
Total amount	$5,000.00		
Less: Portion expended in 1939	1,036.71		
	$3,963.29		3,963.29
Less: Portion expended in 1940	2,590.98		
	$1,372.31	1,372.31	
Centenary Sustaining Fund, per statement		4,450.47	3,387.55
Life membership reserve		2,411.91	2,401.87
Unearned income:			
Dues		610.42	1,269.25
Subscriptions		1,363.92	1,391.25
Surplus, per statement		4,967.24	5,951.23
		$15,820.51	$19,968.11

AMERICAN STATISTICAL ASSOCIATION

INCOME STATEMENTS

	Year ending December 31, 1940	Year ending December 31, 1939
INCOME:		
Dues—current year	$13,151.71	$11,407.00
Dues—prior years	37.50	30.50
Life memberships (see note)	280.03	175.00
Subscriptions	3,394.50	3,511.50
Advertising	458.04	840.64
Reprints	180.10	180.40
Journal sales	284.33	354.41
Special publications	18.04	23.87
Miscellaneous	91.18	98.20
Dividends and interest (after deducting $95.27 in 1939 and $96.07 in 1940 apportioned to life membership reserve)	101.08	202.84
	$18,004.91	$16,809.45
Appropriation from Centenary Sustaining Fund	1,500.00	
The Rockefeller Foundation grants:		
For general purposes	1,500.00	3,000.00
For Index to the Journal (appropriation to cover expenses for year, per contra)	2,500.08	1,036.71
	$23,055.89	$20,036.16
EXPENSES:		
Journal—printing, mailing and reprints	$ 5,048.25	$ 4,003.08
Bulletin	402.84	370.30
Salaries and wages	12,200.20	11,447.20
Unemployment compensation tax	281.30	342.11
Rent	900.00	918.00
Office supplies, printing and mimeographing	725.92	825.36
General postage and carriage	535.20	531.85
Telephone and telegraph	212.45	245.07
Travel expense—officers	370.07	416.73
Travel expense—committees		23.40
Mimeographing—committees	10.02	38.70
Storage of old Journals	72.00	72.00
Cost of old Journals sold	40.70	60.95
Miscellaneous expense	200.54	407.08
Depreciation of furniture and equipment	110.06	123.44
Centenary celebration		368.51
Centenary membership campaign		474.61
Membership directory	701.15	
Expense—Index to the Journal (expended from Rockefeller Foundation grant, per contra)	2,500.08	1,036.71
	$24,030.88	$22,600.00
Excess of expenses over income, charged to surplus	$ 983.00	$ 1,750.93

Note: In accordance with a resolution of the Board of Directors, March 31, 1936, the life membership reserve is computed on the basis of the combined

annuity table of mortality with assumed interest at 4% per annum and an assumed annuity of $5.00 per life member. The amount treated as income in each year represents the excess of the reserve at the beginning of the year plus interest for the year and new life membership receipts over the required reserve at the end of the year.

AMERICAN STATISTICAL ASSOCIATION

SURPLUS STATEMENT

	Year ending December 31, 1940	1939
Balance at beginning of year	$5,951.23	$7,990.04
Deduct:		
Excess of expenses over income for the year per income statement	$ 983.99	$1,759.93
Loss on sale of securities		278.88
	$ 983.99	$2,038.81
Balance at end of year	$4,967.24	$5,951.23

STATEMENT OF CENTENARY SUSTAINING FUND

	Total	Year ending December 31, 1940	1939
Contributions and pledges (see note)	$10,696.02		
Less: Pledges not collected at December 31, 1940, including $3,886.05 not due at that date	3,993.25		
Amounts received from contributors	$ 6,702.77	$2,551.77	$4,151.00
Interest received on bank savings account	24.23	24.23	
Total cash receipts	$ 6,727.00	$2,576.00	$4,151.00
Less: Expenses of campaign (printing, postage and temporary assistance)	776.53	13.08	763.45
Net receipts from campaign	$ 5,950.47	$2,562.92	$3,387.55
Appropriation by the Board of Directors to the general account of the Association in accordance with the budget for the year 1940	1,500.00		
Balance December 31, 1940, per balance sheet	$ 4,450.47		

Note: The Centenary Sustaining Fund was created in connection with the solicitation of contributions toward the support of the activities of the Association for a period of five years from January 1, 1940 to December 31, 1944.

List of Committees and Representatives for 1940

Committee on Fellows[1]

Walter A. Shewhart
F. Leslie Hayford
Frank A. Ross
W. Leonard Crum
John Rice Miner

Committee on Nominations

Ralph J. Watkins, *Chairman*
Henry B. Arthur
Helen M. Walker

Committee on Investments[2]

F. Leslie Hayford, *Chairman*
George O. May
Walter W. Stewart

Biometrics Section Committee

Hugo Muench, Jr., *Chairman*
Joseph Berkson, *Secretary*
C. I. Bliss
Alfred J. Lotka
J. Neyman
Carroll E. Palmer
George W. Snedecor

Census Advisory Committee

Robert E. Chaddock,[3] *Chairman*
Murray R. Benedict
Paul T. Cherington
J. Frederic Dewhurst
William F. Ogburn
Willard L. Thorp

Committee on Census Enumeration Areas

Howard Whipple Green, *Chairman*
Clarence E. Batschelet
Robert E. Chaddock[3]
Ernest M. Fisher
Charles S. Newcomb
Vergil D. Reed
Leon E. Truesdell

Committee on Statistics of Delinquents and Criminals

Thorsten Sellin, *Chairman*
Ronald H. Beattie
C. E. Gehlke
Rolf T. Harbo
LeRoy C. Schaeffer
C. C. Van Vechten
George B. Vold

[1] With terms expiring at the end of 1940, 1941, 1942, 1943, and 1944, respectively.
[2] Appointed in accordance with By-Law 5 to supervise the investment of the Association's surplus funds.
[3] Deceased October 21, 1940.

Committee on Labor Statistics

J. Frederic Dewhurst, *Chairman*
Meredith B. Givens, *Vice-Chairman*
Ewan Clague
O. A. Fried
Edward D. Hollander
Aryness Joy
Solomon Kuznets
Gladys L. Palmer
Eugene B. Patton
Paul L. Stanchfield
Sidney W. Wilcox

Joint Committee on Metropolitan Districts (With the American Marketing Association and the Chamber of Commerce of the United States)

Paul T. Cherington,[4] *Chairman*
T. W. Howard[5]
Glenn E. McLaughlin

Joint Committee on Occupational Classification (With the Division of Statistical Standards, Bureau of the Budget)

Howard B. Myers, *Chairman*	Work Projects Administration
P. K. Whelpton,[6] *Secretary*	Division of Statistical Standards, Bureau of the Budget
E. Dana Durand	Division of Statistical Standards, Bureau of the Budget
Meredith B. Givens	New York State Department of Labor
Edward D. Hollander	Bureau of Employment Security, Social Security Board
Aryness Joy	Bureau of Labor Statistics, Department of Labor
Merrill G. Murray	Bureau of Old-Age and Survivors Insurance, Social Security Board
Gladys L. Palmer	American Statistical Association
Leon E. Truesdell	Bureau of the Census, Department of Commerce

Joint Committee on Relief Statistics (With the American Public Welfare Association)

Ralph G. Hurlin, *Chairman*
Paul Webbink, *Secretary*
Neva R. Deardorff
Emil Frankel
Anne E. Geddes
Helen R. Jeter
Howard B. Myers
Emerson Ross
Saya S. Schwartz
Herman M. Somers
Emmett H. Welch

[4] Appointed by the American Marketing Association.
[5] Appointed by the Chamber of Commerce of the United States.
[6] Resigned May 18, 1940.

Committee on Chapters

Robert R. Nathan, *Chairman*
Henry B. Arthur
Edwin B. George
Lester S. Kellogg
William A. Sturm
Charles W. Vickery, Jr.
Robert R. Williams

Advisory Committee to the National Roster of Scientific and Specialized Personnel

Halbert L. Dunn
Walter Mitchell, Jr.
Frederick F. Stephan
Ralph W. Tyler
Samuel S. Wilks

Representative on the Board of Directors of the National Bureau of Economic Research

Winfield W. Riefler

Members of the Social Science Research Council[1]

Edwin B. Wilson
O. C. Stine
Stuart A. Rice

Representative on the Council of the American Association for the Advancement of Science

Walter A. Shewhart

Representatives on the Joint Committee for the Development of Statistical Applications in Engineering and Manufacturing

Walter A. Shewhart
Churchill Eisenhart

Representative on the Sectional Committee on Standards for Graphic Presentation

A. H. Richardson

Member of the American Documentation Institute

Frederick F. Stephan

Representative on the Advisory Board of the American Year Book

Frank W. Notestein

Representative on the Advisory Committee to the Census Library Project

Richard O. Lang

[1] With terms expiring at the end of 1940, 1941, and 1942, respectively.

BOOK REVIEWS

GLENN E. McLAUGHLIN
Review Editor

An Appraisal of Frederick C. Mills' The Behavior of Prices, by Raymond T. Bye. New York: Social Science Research Council. Critiques of Research in the Social Sciences: II. Bulletin 45. 1940. xix, 335 pp. $1.00.

This volume represents the second effort on the part of the Social Science Research Council "to see whether objective standards can be inductively arrived at for judging research product and for putting such standards to practical use." Besides Professor Bye's *Critique* of "The Behavior of Prices" which was the first "research product" chosen to represent the discipline of economics, this volume contains other parts. These include an effective rejoinder by Frederick C. Mills, reprints of earlier reviews of "The Behavior of Prices" by Jacob Viner and Bruce D. Mudgett, and the *pièce de resistance*, a verbatim account of the discussion of a panel of economists chosen for their competence to appraise Professor Mills' contribution to economic research. There is also a brief statement by Wesley C. Mitchell and a commentary by Read Bain. Since several of the panel members did not agree that Professor Mills' book was mainly concerned with economic research, it is not surprising that unanimity of opinion seldom occurred. The brilliance of statistical techniques evolved by Professor Mills for the study of prices was generally conceded, but complete agreement seemed to end there.

Professor Bye begins his *Critique* by characterizing "The Behavior of Prices" as "a bold and interesting attempt to apply new methods to the central problem with which economists for several generations have been concerned, in the hope of reaching scientific generalizations of an entirely different character from those which have hitherto been developed." He describes it as "a Herculean labor." There is a change of tone, however, as the appraisal proceeds. Mills is criticized for omissions which themselves might well have required treatment quite as extensive as the analysis in "The Behavior of Prices." Before he has done, Professor Bye is of the opinion that "Such analysis is certainly legitimate—as far as it goes." The "bold and interesting attempt" becomes doomed to yield generalizations which are superficial because "any generalization reached by a study of the price system entirely abstracted from all other economic phenomena, as Mills' study is, must be rather superficial." The work is criticized because it views only one part of the price system—wholesale prices, and because of its lack of *a priori* background. Professor Bye apparently shared with several other members of the panel the view that Mills should have outlined in more detail the deductive considerations which led him to frame his statistical attack in the manner which it was made.

Mills' rejoinder contains a section on *The Methods and Objectives* of the "Behavior of Prices" which would have formed a valuable introduction to

his book, and perhaps might have prevented much of Bye's criticism. The rejoinder as a whole is a convincing statement of the case for inductive research aimed at the "accretionary development of knowledge" as opposed to "system building."

In a note of this length it is not possible to make more than a passing comment upon the reviews of Viner and Mudgett. The former is critical of a technique "ill adapted to finding out *what questions to ask*," the latter sees more promise in Mills' independent approach and new techniques. The validity of Mudgett's criticism concerning the concept of a "*general business cycle* as a gargantuan force, causal in character" is admitted by Mills in his rejoinder.

"Proceedings of the Conference on Bye's *Critique*" is scarcely an accurate title for Part Two of this volume. During the morning session of the panel the time-worn controversy of the merits of inductive and deductive approaches to economic problems was revived, and the argument developed considerable heat. This question received more time than was spent upon judging "The Behavior of Prices" as a "research product." There was also considerable time consumed in deciding what various speakers meant when they used such innocent looking words as "grouping," and "descriptive." Introduction of the word "normal" produced repeated references to Marshall and what he meant. Said speaker number one—"I don't think that is true of Marshall." Replied speaker number two—"I think there is a shade of it in Marshall."

The afternoon session was devoted to business cycle theory, and practical uses of neo-classical analysis among other topics, with scattered references to "The Behavior of Prices." There was no attempt on the part of the panel to sift its opinions of the book, but this was done very fairly by Read Bain in his concluding commentary on the conference.

Analogies are seldom exact and may be quite unfair, but this volume reminded the writer repeatedly of the story of the tower of Babel. No doubt there were many excellent tower builders assembled at Babel. It is sad to reflect that their desire to mingle with the angels apparently was frustrated by inability to decide upon the language which would be spoken in planning the ascent.

HAROLD F. GREENWAY

Dominion Bureau of Statistics
Ottawa, Ontario, Canada

Monopolistic Competition and General Equilibrium Theory, by Robert Triffin. Cambridge, Massachusetts: Harvard University Press, 1940. xiii, 197 pp. $2.50.

Discussion of monopolistic competition in economic journals has been largely concerned with detailed corrections or terminological controversies.

It is therefore interesting to find a full-length review and development of the subject as a whole. While mainly a work of exegesis, Dr. Triffin's study also makes original contributions which reveal theoretical competence and expository skill.

The comparison and criticism of the work of Chamberlin, Robinson, Pareto, and von Stackelberg will prove illuminating to those already acquainted with these writers. Monopolistic competition theorists are criticized primarily for their continued reliance on the concept of a "group" or "industry" while dealing with admittedly non-homogeneous products. Whatever the value of such a concept in empirical investigations, Dr. Triffin contends that it is useless for theoretical analysis. There is no logical stopping-point between the individual firm and the entire economic collectivity.

He therefore proceeds to build his own theory on the individual firm as unit, without recourse to any type of grouping. This "theory of external interdependence" is strictly speaking a set of definitions rather than a working model. The definitions offered are both logical and ingenious. Selling relationships among firms, for example, are classified into five types: isolated selling; heterogeneous competition, which may be either atomistic or oligopolistic (circular); and homogeneous competition, which may also be either atomistic or circular. Also interesting are the definitions of free entry, homogeneous entry, heterogeneous entry, and closed entry. Free and closed entry are presented as logically opposite poles rather than as all-inclusive categories, with nearly all actual cases falling somewhere in between.

It follows that the presence or absence of profits cannot turn on the existence of free or closed entry. Following Schumpeter, Dr. Triffin contends that profits arise through "innovation." They can be competed away only in the very special case where competitors are able to produce an identical product at identical cost (free entry). But they do not remain indefinitely in the hands of the entrepreneur—"the surplus soon melts away into increased remuneration to the various elements composing the firm . . . The stability of these rents will depend upon the possibility of competition from other, more or less similar factors." The profitless character of the circular flow, which Dr. Triffin takes as characteristic of *both* monopoly and competition, *both* free and closed entry, thus arises solely from imputation.

Except for this treatment of profits, the book presents no positive theoretical structure. It is concerned with the less spectacular but more basic task of destroying faulty concepts and substituting new ones. Economists have been uneasily aware for some time of the logical loopholes in such traditional concepts as "normal profit," "free and closed entry," "industry," "pure monopoly." Dr. Triffin has brought these doubts out into the open and has done some valuable ground-clearing work. We still stand in need, however, of a fully-elaborated "theory of external interdependence." Perhaps the most immediate need is an analysis of oligopolistic circularity, touched on at several points in this study but nowhere fully explored. When this

problem is squarely tackled, may not the banished concept of a "group" reappear through the back door?

LLOYD G. REYNOLDS

Johns Hopkins University

Statistical Mathematics, by A. C. Aitken. New York: Interscience Publishers, Inc. 1939. vii, 153 pp. $1.50.

In a very clear-cut and elementary manner this little book gives a survey of the mathematics underlying the simpler statistical techniques. No mathematics beyond introductory calculus is used. The author begins with a brief informal discussion of three definitions of probability: (1) The Keynes definition of probability as the logic of uncertain inference, (2) The von Mises or relative frequency definition, and (3) the measure definition due primarily to Kolmogoroff. It is pointed out that (3) is really a rehabilitation of Laplace's original *a priori* definition by giving it a more satisfactory axiomatic basis, and the author casts his preference for this definition. The presentation of measures of central tendency and dispersion, moments, semi-invariants, curve-fitting methods and other material on the description of probability and frequency distributions is very concise. This is one of the very few books on elementary statistics in which probability-generating functions and moment-generating functions are discussed and used. These tools are extremely powerful although rather simple in nature when properly defined in connection with discussions on mean values. The reviewer does not mean to give the impression that no deep mathematical questions are to be encountered in a thorough understanding of generating functions and their use and limitations in statistics. In dealing with distributions of two or more variates the author makes a great deal of formal use of generating functions of several variables. His treatment of the Pearson Chi-square distribution law proceeds on basis of generating functions, although much is left for the reader to verify. The chapter on multivariate correlation and least squares and its application to polynomial and harmonic regression is rather classical. The final chapter is devoted to sampling distributions of means, difference of means, mean squares, "Student's" ratio, Fisher's z-ratio, and the correlation coefficient, together with some remarks on randomized blocks, Latin squares, and the problem of estimation. This chapter, however, is typically survey material and is hardly detailed enough to give the serious student an opportunity to find out how sampling theory is really developed and how it is used in problems of statistical inference. The treatment of the rationale underlying significance tests and statistical estimation is rather incomplete.

In spite of its brevity and survey-type of approach, this book would be an excellent text in an introductory course in mathematical statistics, which could serve as a foundation for a good solid course in statistical inference. One weak point in the book as a text, however, is that it does not

contain enough examples for the student to carry out. This disadvantage is offset to some extent by the fact that in most sections steps are omitted and left to the reader for verification.

S. S. Wilks

Princeton University

Speed Methods of Statistics for Use in Business, by Donald E. Church, New York: The Ronald Press Company. 1940. ix, 97 pp. $3.00.

By "speed methods" the author means the analysis of time series by the use of logarithmic graphs. Great efficiency is achieved by the use of a simple mechanical device, described in detail, that permits the log charts to be employed like a slide rule for multiplying and dividing. Since these operations are essential in the calculation of index numbers, seasonals, cycles, and correlation, the methods have extremely wide application. The author believes that the methods suggested permit a possible savings of three-fourths the usual clerical cost. For those unfamiliar with statistical analysis, an explanation is given of the nature, use, and significance of the measures commonly employed in the study of time series. It would appear, however, that the successful use of the very carefully described technique is limited in the main to those with some training in statistics or mathematics.

David Schenker

University of Pittsburgh

The Preservation of Business Records, by Ralph M. Hower. Boston: The Business Historical Society, Inc. 1940. 56 pp.

The Business Historical Society, Inc., has performed a definite service to statistical and other research workers by the publication of a study that outlines why business records should be preserved; what material should be selected for retention; how such material should be preserved; and the actual policies and practices of particular business firms in the fields of advertising, banking, insurance, investment, manufacturing, transportation, and wholesale and retail trade.

The recent publication by the General Foods Corporation of "A Calendar of Walter Baker and Company and its Times, 1765–1940" would seem to vindicate the claims of the Society's publication regarding the advertising value of information contained in ancient business records. It is felt, however, that still greater emphasis could have been placed upon the value of business records in connection with current research activities relating to the problems of efficient administration.

Dr. Ralph M. Hower, the author, has done pioneering work in his effort to outline a retention program covering accounting, purchasing, production, inventory, labor, sales, statistical, and other groups of records. From the historical standpoint his recommendations in this respect leave little if anything to be desired, although there is some question in the mind of this re-

viewer as to whether some business firms, particularly those of smaller size, could develop procedures and actually preserve all of their records of the indicated types.

In referring to the selection and disposal of records, emphasis is rightly placed upon the need for centralized planning and control. Greater emphasis, in this connection, might have been placed upon the need for *current* selection of particular documents to be permanently preserved; also upon the need for standardizing the whole process of administrative documentation including the methods of classification and filing.

The discussion of grades of paper and inks to be used is well handled as is also the sections dealing with modern methods of photographic duplication, particularly through the application of microphotography. Attention might have been called to record preservation by means of "lamination" which is now coming into general use. Proper emphasis is placed upon the desirability of selecting material which is to be preserved only in samples. All things considered this study appears to be a timely and useful one which should promote the preservation of great bodies of research material of the highest value to statisticians, social scientists, and to historians.

DORSEY W. HYDE, JR.

The National Archives

Whale Oil, An Economic Analysis, by Karl Brandt. Stanford University: Food Research Institute. 1940. xi, 264 pp. $3.00.

Whaling, like many other aspects of maritime affairs, has suffered from an overabundance of narratives and personal reminiscences and an extreme scarcity of scholarly works by competent economists who were able to employ the methods of scientific research. Professor Brandt's volume goes far towards remedying this defect. It is an excellent book.

As the title indicates, the work is concerned primarily with an economic and statistical analysis of the fishery's chief product, whale oil. There is extensive material bearing upon costs, prices, and profits—all subject to wide and unpredictable variations. There are illuminating descriptions of the complicated and rapidly-improved technology of modern times, which has registered truly remarkable improvements in the hunting of the game, in the extraction of the oil, and in the development of by-products. Tariff duties, excise and processing taxes, and other regulatory devices are considered in detail, with special reference to the peculiar position in the United States, where whale oil has become the center of attention in the tariff struggle between the domestic fat-producing interests and the fat-consuming industries. The marketing of the oil is also discussed at considerable length, since it presents problems of price determination which are both complicated and challenging. Whale oil is essentially a product for the world market, and one which is used in competition with and as an actual or potential substitute for other fats and oils in the manufacture of soap, margerine, and shortening or lard compounds. Because of this element of potential competition it has

an influence out of all proportion to its volume upon the price structures of many other fats and oils originating in various products ranging from soy beans to peanuts. But in spite of its world-wide market and its influence upon many other products, it was produced before the present war predominantly by a small number of interests which were centered largely in Norway, Great Britain, and Japan, and was bought mainly by an even smaller number of cartel-like interests for sale and use chiefly in Great Britain and Germany.

In addition to this major topic of whale oil, however, the author very properly considers various allied and corollary matters as well. There is an abbreviated but suggestive account of the historical background of whaling; and the sharp contrast between the modern twentieth-century industry and its forbears is pointed out. The element of international competition is analyzed, with special reference to the present keen divergence of interest between two groups—Norway and Great Britain, which have a dominant position and wish to stabilize the fishery through international regulation in order to avert the possible exhaustion of the supply of whales, and Japan and Germany, which are seeking to expand their whaling industries and are consequently opposed to rigorous limitation of catches. This major rivalry has so far spoiled all chances for a really effective form of international cooperation, in spite of the obvious and even pressing danger of overfishing to the point of literally killing the industry, or at least of reducing it again to negligible proportions. There have been several international conferences and conventions, but their accomplishments have been out of all proportion to the need for regulation and limitation of the annual catches.

In conclusion, it may be added that Professor Brandt has shown good judgment in avoiding two dangers. He does not attempt to gloss over the complexity and variability of his subject-matter by pretending to secure precise and exact results where it is obvious that the very nature of his material does not permit this; and he does not lapse into easy optimism and closing platitudes with regard to the future development of the industry, which needs thorough international regulation.

Elmo Paul Hohman

Northwestern University

Industrial Opportunity in the Tennessee Valley of Northwestern Alabama, by Herman Frederick Otte. New York: Columbia University Press. 1940. x, 177 pp. $2.25.

This is a study of present and prospective developments in the seven counties of northwestern Alabama which embrace the lowlands paralleling the Tennessee River and that section of the River which formerly covered a thirty-seven-mile stretch of rapids, known as Muscle Shoals. The significance of the study lies in the fact that it is an evaluation which covers intensively a small, geographically distinct, homogeneous area that many interests have sought intermittently for more than half a century to develop.

Current attention grows out of the Wilson Dam project which the Federal Government started in 1917 and Henry Ford offered in the early twenties to take over and develop into a "Seventy-Five Mile City" and which the Federal Government later completed and expanded into the Tennessee Valley Authority.

The author traces carefully the economic history of the area and then presents chapters on the existing manufacturing industries, available raw materials, industrial sites, markets, and human resources. A concluding chapter deals with prospective developments. The area under scrutiny is small enough both for intensive field work and for careful study of a wide range of secondary material, much of it of a technological nature, all of which has a bearing on the complex problem under study. The author appears to have been well equipped, especially along geographic lines, for both types of effort. The evidence seems to have been objectively considered and the conclusions are balanced, scholarly ones. The weakest chapter is the six-page summary dealing with the industrial prospects of the area. The reviewer feels that many of the detailed conclusions concerning the future, carefully worked out in the preceding chapters, might have displaced to good effect the more general concluding statements. The reader who turns first to the final chapter is likely to form conclusions concerning the quality of the book which are unfair to the author.

ALFRED H. WILLIAMS

University of Pennsylvania

A Comparative Study of the Seasonal Incidence of Mortality in England and Wales and in the United States of America, by E. Lewis-Faning. New York: British Library of Information, 1940. 69 pp. 30 cents.

This study was suggested by an examination of the seasonal variations in the mortality data for the large towns of England and Wales, Germany, and the United States which showed that in England and Wales the usual winter maximum was more pronounced than in other countries. In the belief that the unfavorable winter mortality in England and Wales might be due to remediable conditions, a detailed study was undertaken to determine the seasonal incidence of mortality for 24 causes of death.

The analysis includes monthly mortality data (corrected for age and sex) relating to the period 1931–1935 for England and Wales and to the years 1931–1934 for the United States. Special reference to corresponding data for the New England States is made because it was felt that certain factors such as population density, area, racial composition, and climate of the New England States approached more nearly to the corresponding conditions in England and Wales than did those factors in other States or the United States Registration Area. Only a limited use is made of the German statistics because they were not sufficiently comparable.

In the comparison of the principal statistical features of the various dis-

cases, the causes of death are classified into five groups according to the characteristics of their seasonal distribution. In general, the results indicate that the winter mortality in England and Wales is relatively higher and the summer mortality rates relatively lower than those for the United States. However, the net effect of these differences is that the winter excess in mortality in England and Wales overbalances the summer advantage over the United States. Except for a marked reduction in the difference between the summer mortality rates, these disparities still exist when the English data are compared with those of the New England States.

The unfavorable winter mortality experience in England and Wales is attributed to respiratory diseases, namely, bronchitis, pneumonia, influenza, and tuberculosis of the respiratory system. A supplementary analysis of the age and regional distributions of bronchitis and pneumonia is made in view of the importance of these diseases as a cause of death. The two major causes of death responsible for the higher death rate in the United States in July as compared to the rate for England and Wales were found to be diseases of the heart, and violence.

The author does not believe that the seasonal differences found between the mortality data for England and Wales and the United States are due to climatic factors but feels that the explanation may more reasonably be sought in differences in hygienic conditions. The author concludes that "the present study contributes, from another angle, a further argument in support of the general conclusion that there is much preventable mortality in Engand and Wales which is not in fact prevented."

Halbert L. Dunn

Bureau of the Census

The Youth of New York City, by Nettie Pauline McGill and Ellen Nathalie Matthews. New York: The Macmillan Company. 1940. xxvi, 420 pp. $3.50.

The authors of this volume present the findings from a study made mainly under their planning and direction by the Research Bureau of the Welfare Council of New York City with the assistance of the state and city work relief authorities and of the Works Progress Administration. The investigation dealt with a sample of 9,041 young persons between the ages of 16 and 24, inclusive, residing in greater New York in 1935. This number represented a sample of approximately one per cent of the youth population. The sample was drawn from households contained in the files of the *Real Property Inventory*. Information concerning the educational and employment status and history, and the educational, vocational, and avocational activities, interests, and attitudes of youth of this age group was collected by securing through interview answers to questions on a schedule consisting of 101 items and by a time record of all activities during a "sample" week immediately preceding the interview. The appendixes include discussions of the scope

and method of the study, and of the representativeness of the sample, in addition to the schedule and statistical tables.

The volume contains a wealth of interesting and informative material. The significance of the findings is educed through careful reasoning without the tendency to uphold any particular proposal for social action. While the study was mainly exploratory, it often probed sufficiently deep to touch the foundations of a number of youth problems. The problems of youth appear to be much the same in our largest city as in small communities as shown by the common findings of this study and of other studies of youth. Only a few of the more significant conclusions and implications can be mentioned here.

Unemployment during the decade of the 1930's has affected workers of all ages but has fallen disproportionately heavily upon youth. The chances of employment are greatest for those who have had work experience, and since youths have not had this experience they are not only discriminated against when employment opportunities arise but remain disqualified because they cannot get experience.

Although most youths enter high school, less than half of those who enter are graduated. The schools partly through inertia and partly through lack of resources and vision have been unable to provide for new and changing social and economic conditions and work opportunities. Moreover, those youths who drop out of school earliest are the most handicapped economically and socially. The youths who did secure jobs, were dominantly employed at work incommensurate with their interests, levels of abilities, and training.

While abundant time is available to unemployed youth for what is termed leisure-time pursuits, this time consists of hours of boredom or of empty hours which fall upon those who are not trained for the worthy use of leisure. While there would likely be some change in the leisure activities and attitudes of youth were it possible for them to become engaged in the world's work, it would probably still be true that most young people, especially after leaving school, are not interested in and are not prepared to participate in constructive leisure-time activities.

PALMER O. JOHNSON

University of Minnesota

The Labour Cost of the World War to Great Britain, 1914–1922, A Statistical Analysis, by N. B. Dearle. New Haven, Connecticut: Yale University Press. 1940. ix, 260 pp. $2.00.

The valuable collection of World War studies published under the auspices of the Carnegie Endowment for International Peace has not been enriched a great deal by this monograph. Neither in content nor appearance is it very satisfactory. This is much to be regretted; for the drawing up of a labor balance sheet for Great Britain covering the first World War and the consecutive demobilization period is a significant research problem.

Dr. Dearle has collected a considerable amount of statistics on the impact

of the first World War on the British labor market. He evaluates the reduction of labor supply by the calling of men to the military forces, and the degree to which it was compensated for by the diversion of unemployed or uneconomically employed labor to industrial activity, by the reduction in trade disputes and industrial accidents, and by the decline of Britain's emigration surplus. As compared with conditions which would have arisen if the war had not disturbed the trends prevailing during the pre-war period, the United Kingdom seems to have lost the equivalent of roughly two million male workers per year during the four years of war, and again the same number during the demobilization period from November 1918 to December 1922.

The yearly war loss amounted to about 10 per cent of the total occupied population in July 1914, according to an estimate of the Board of Trade, quoted in the book. This shows that military mobilization did not reduce Britain's labor supply to a great extent, at least not in so far as aggregate numbers are concerned. Of course, the number of workers available for purely civilian pursuits was curtailed to a much larger extent. According to Dearle, an additional three million workers per year were "lost" through their diversion to war production between 1914 and 1918. Hence, for the average war year, the proportion of worker-years withdrawn from civilian work amounted to about 25 per cent of the 1914 total.

The book contains material which may be of considerable interest, for instance, figures indicating a decline of the relative frequency of industrial accidents under war conditions. But the statistician will be disturbed by the lack of information on sources, the incomplete explanation of concepts used, and the uneven discussion of procedures and results. These shortcomings, together with the obvious lack of editorial care, create the impression of an unfinished work and seriously impair the usefulness of the book for reference purposes.

The student of war economics may resent Dr. Dearle's practice of drawing the balance sheet of labor in war for the four-year period as a whole. The per-year averages, in terms of which the results are stated, are fictitious averages. The war effort they depict is far above the actual British war effort of 1914 and 1915 and far below that of 1917 and 1918.

HORST MENDERSHAUSEN

National Bureau of Economic Research

Wage Differentials: The Case of the Unskilled, by Carrie Glasser. New York: Columbia University Press. 1940. 169 pp. $2.00.

This interesting study marshalls the evidence with respect to the existence of long-term wage differentials among a group of workers of broadly comparable skill. The wages studied are those of unskilled labor; the data used are average hourly entrance rates for male common labor, 13 industries, 1926–1937 (U. S. Bureau of Labor Statistics); average hourly earnings and

average weekly earnings of male unskilled labor, 21 manufacturing industries, 1920-1937 (National Industrial Conference Board); estimated annual earnings of unskilled labor, 20 manufacturing industries, 1923-1931. Admittedly the homogeneity of the worker-group is not perfect; it is probable, therefore, "that some of the differentials to be observed in the data arise because of differences in skill. . . ." Moreover, short-run wage differentials among comparable groups of workers in different industries or regions may appear because of temporary alterations in the condition of industry or regional labor markets. The period studied, in consequence, must be long enough to indicate whether differentials are persistent.

Dr. Glaser does not attempt to measure the *extent* of wage differentials among unskilled workers in different industries. She does seek to show, by the use of ranks, the industries in which wages are persistently high or persistently low. In the case of average hourly entrance rates, for example, each industry is ranked for each year from 1926 to 1937. The sum of the annual ranks indicates the final rank of each industry. Various measures of the stability of the annual ranks are set forth. Since the data indicate that the ranks of the industries are reasonably stable over the period covered, she concludes that "differentials in average hourly entrance rates of common labor are persistent."

This same procedure, leading substantially to the same conclusion, is used for average hourly earnings, average weekly earnings, and estimated annual earnings. The rank method applied to entrance rates is also employed to show the persistence of differentials among industries within the North and South; other tests are utilized to reveal the persistence of interregional differences in wages. There is an interesting chapter on the dispersion of wages, in which coefficients of variation are computed for each year for each series. In general, these coefficients fail to indicate the existence of a wage differential behavior pattern during up- and down-swings of the business cycle.

The persistence of wage differentials points to imperfect labor mobility and an uneconomic allocation of labor among employments. The second part of this volume deals with certain aspects of the theory of wages and with the causes of imperfect labor mobility. This discussion does not add significantly to our knowledge of these subjects, but does bring together scattered information in a useful fashion.

H. M. DOUTY

Wage and Hour Division
U. S. Department of Labor

Whither Interest Rates?, An Appraisal of Pressures in and From the Capital Markets, by Harland H. Allen. New York: Harper & Brothers. 1940. xii, 106 pp. $2.00.

After two decades of decline, interest rates now are lower than ever before. The present yield of AAA corporation bonds is about 2.75 per cent. The long-

est issue of United States Government bonds—the 2¾'s of 1960–1965—yield only about 2.10 per cent; and because of its complete exemption from income taxes a recent issue of serial obligations by the State of Connecticut sold to yield from .5 per cent for the 1944 maturity to 1.52 per cent for the last maturity, 1971. In his examination of this downward trend of interest rates the author has attempted not only "to see what have been the important causes of this decline" but also "to segregate and appraise these factors with particular reference to their present vigor and prospective potency."

His investigation reveals that interest rates have tended to be forced down because of the decreased demand for loans brought about by a cessation of foreign borrowing in this country, and because of a tendency for corporations to expand by internal financing. Likewise, an increase in the supply of capital savings through life insurance companies has accentuated the downward trend.

These three important factors—the two affecting demand and the one affecting supply—are the ones which must be compensated for if interest rates are to be higher in the future. For signs of possible changes in the levels of money rates one must watch these deep-seated causes "which do not appear likely to be erased by the passing of a few years" rather than bank deposit volume, gold supply, or commercial loans.

Since it appears that the pressures in the capital market responsible for low interest rates have not spent their force or ceased to be important the author feels it necessary to analyze the social, economic, and political implications entailed in the necessary adjustments to the new low level of interest rates, and devotes about a fourth of the book to that end. The author's conclusion, or rather "his present conviction is that, on balance, the disadvantages and penalties of low interest rates are probably fully offset, if not more, by the advantages—conditions in this era being what they are." While this conclusion may not be acceptable to everyone, the author still deserves praise for his stimulating and realistic discussion of the factors determining the rate of interest.

Kenneth Lewis Trefftzs

Carnegie Institute of Technology

Michigan Tax Trends as Related to Agriculture, by Denzel C. Cline. East Lansing, Michigan: Agricultural Experiment Station, Michigan State College. Special Bulletin 301. February, 1940. 88 pp.

The Michigan tax system has been revolutionized since 1930, particularly in its effect upon Michigan farmers. In 1930, Michigan was the third highest state in the average amount of farm real estate taxes per $100 of value as reported by the U. S. Department of Agriculture, but by 1937 it had dropped to fortieth place. Factors chiefly responsible for this shift are the (1) adoption of the 15-mill limit on the property tax rate, (2) removal of the state levy

on property, (3) reduction of assessed valuations, (4) transfer of township roads to the counties and the almost complete shift in the support of rural roads from the property tax to motor vehicle taxes, (5) expansion in state aid for education and welfare, and (6) imposition of the retail sales tax.

To provide perspective on the whole tax situation, the first two sections of this study portray trends in property taxation and the state and local revenue system during the past 25 years. The remainder of the bulletin is devoted to taxation trends in relation to agriculture. Analysis of the changes in 200 agricultural townships in section three, reveals that (1) as a result of larger state aid for schools and elimination of the levy for state purposes and for rural road support, the tax levy in most of these townships was materially less than could have been imposed under the 15-mill limitation, and (2) reduction in highway levies was responsible for 48 per cent of the total decrease in property taxes. Because of the importance of this latter factor, a separate section describes the transformation that has occurred in rural highway administration and finance. Presentation of the material is enlivened by a series of illuminating diagrams and charts.

This is an excellent monograph that will be of interest to students of taxation. Although based on the Michigan situation, the study has wider significance because other states have experienced somewhat similar changes.

ROBERT S. FORD

University of Michigan

Portfolio Policies of Commercial Banks in the United States, 1920–1939, by Pearson Hunt. Boston, Massachusetts: Bureau of Business Research, Harvard University. 1940. v, 58 pp. $1.50.

After reading this monograph, these reviewers are left with the distinct feeling that the result does not match the title. It would seem, from the product, that it might more accurately be titled, "Portfolio Changes . . ." The first few pages are a preliminary survey of the suitability of available data. In these, Dr. Hunt demonstrates why national bank figures are used as an accurate sample of the condition of all commercial banks in the United States. It would be difficult to question or disprove his evidence.

An eyebrow or two must be raised, though, when coming upon, "This division of earning assets on the basis of their expected manner of liquidation means that we can look to changes in their relative importance in bank portfolios *as indicators of changing bank policies with respect to liquidity.*" (Italics ours.)

In generally accepted usage, it would seem that "policy," as associated with management should be voluntarily conscious and deliberate. These reviewers do not subscribe to the idea that the changes which have taken place in the last two decades with respect to commercial loans have been either voluntary or deliberate on the part of commercial bank managements. Rather they have been a forced expediency. Commercial banks are really

institutions of accommodation and not of origination. They do not go out and find places where funds may be used and then try to find someone to borrow funds to use in the manner "discovered" by the bank.

Within the knowledge of these reviewers, such changes as have occurred in bank portfolios, particularly in loans and discounts, have been the reflection of a changed type of demand. Policy or no, if there is no demand for commercial loans, bank portfolios will hold none.

Chapter II describes factual changes in bank portfolios from 1920 to 1939. The author traces clearly the changes in loans and discounts by three classes: loans commercial in form, loans not commercial in form, and real estate loans. Changes in investments are traced by classes, as: United States government obligations, state, county and municipal bonds, railroad and public utility bonds, and others (with some further segregation).

Not surprising is the conclusion that real estate loans have been the most vital of the types of loans and discounts. These have been rather encouraged by liberalization of banking laws.

One feels somewhat marooned by a sentence on page 15, which reads, "It shows also that self-liquidating paper is still the source of about half the volume of the Loans and Discounts of national banks." The reason for the desolate feeling is an earlier footnote, on page 9, which reads, "In the final analysis, no loan can be called self-liquidating until after it has been paid off in the way intended." This may be a fine choice of words, but the author throws himself into the error attributed to others.

Referring to changes in aggregate earning assets, Dr. Hunt's figures show that commercial loans made up an ever-decreasing portion of bank earning assets from 1920 to 1936. There was a slight gain in 1937 and 1938, but in 1939 there was a more drastic decline, bringing the figure to 19.41 per cent, the lowest since at least 1920.

The most interesting part of the study has to do with factors affecting bank portfolios, 1920–1939, which are discussed in Chapter III. But here the author leaves a stone or two unturned. For instance, he gives, as one of the changed ways of financing working capital (i.e., operating capital) needs—which in turn account for a reduction in commercial loans by banks—the effects of more liberal credit terms granted to customers. The question immediately arises, "Where did the seller's additional credit granting power come from?" If the manufacturer is carrying more receivables because of more liberal credit terms granted to his distributors, might this not be the very reason why the manufacturer would be borrowing from the bank—to carry receivables—instead of the distributor borrowing—to carry inventory?

The author recognizes that, as far as its desire for an increased demand in commercial loans is concerned, the banking fraternity should appreciate measures designed to raise the general price level. This deduction is based on the observation that the *value* of current production is of far greater importance than the *volume* of production, since both working capital and bank credit deal in monetary units.

A very interesting comparison is made of the loss ratio on loans and investments. Dr. Hunt finds the loss ratio on investments over the period 1921–1939 was higher than that on loans for every year except 1923 and 1938. But larger recoveries on investments counter-balanced the loss ratio. While there seems to be little difference in the long run between loans and investments as sources of losses, if proper weight is given to the earnings which each class provides, such a phenomenon is of great interest to banks in weak capital positions, as they may be closed before the recoveries begin to be taken.

Next, Dr. Hunt discusses the influences that changes in bank legislation and rulings by supervisory powers are having on bank portfolios. He brings up evidence that the old concept of "eligible paper" has been abandoned as a test of the adequacy of loan policy and that commercial banks will undoubtedly be influenced into making less liquid loans with longer maturities. There is thus an implied duty on the part of governmental agencies to provide ample rediscount facilities where they are required.

To Dr. Hunt an inescapable conclusion is that "most of the present qualitative controls now available to governmental bodies are being used to foster the expansion of commercial bank credit along lines which would have been frowned upon a few years ago." It may again be a choice of words, but there is an implication in the sentence which does not appear proper. These reviewers' observation would be that "such changes in qualitative controls *open the door* to expansion of commercial bank credit along lines formerly frowned on . . . etc."

HAROLD J. HECK
ALEXANDER WALL

Robert Morris Associates

Commercial Bank and Consumer Instalment Credit, by John M. Chapman and Associates. Financial Research Program. Studies in Consumer Instalment Financing No. 3. New York: National Bureau of Economic Research. 1940. xxiv, 318 pp. $3.00.

This is a factual account of the part which formal personal loan and time-sales departments of commercial banks now play in the instalment financing of consumers. It describes: the causes of the recency of banks in consumer credit, the speed with which personal loan departments are developing as auxiliary income producers, the moot legality of the techniques in most states, the economic and social stability of customers who use the service, the sources of business, the favorable collection experience, the factors which make for poor payment records, the spread of charges for consumer credit in terms of effective interest rates, the difficulties of allocating expenses to determine profits accurately, the indirect financing of consumers by loans to specialized consumer credit institutions, and intra- and inter-institutional competition.

The general reader will find the study a careful and informative statistical elaboration of material on consumer credit gathered through questionnaires on a nation-wide scale. Many difficulties of enumeration and compilation in a growing field have been overcome, but the student finishes the book with many questions unanswered. No doubt, some of the answers will appear in the volumes of the Financial Research Program announced on the legal aspects and on the economic implications of consumer credit operations.

In these explanatory volumes we may, perhaps, expect discussion of important problems omitted from the descriptive volumes, such as: imperfect competition in consumer credit, control and regulation across as well as within institutional lines, sharper distinction between consumptive and productive finance, the propriety of consumer debt financing through deposit creation, the degree to which the low-cost and the low-loss experience of the personal loan departments of commercial banks may depend on the extent to which they can rely on higher-cost lenders to bail them out of troublesome deals, the social and economic implications of the changes in the financial mechanism of our economy of which consumer credit is part.

From the chapter on risk factors, in which he might have hoped to find practical guidance, the practical operator, faced with a decision to risk his money on a specific applicant for a loan, turns with an increasing sense of bafflement. As he plows through the technical presentation, the banker is presented with a series of indexes, each of which is carefully qualified but not synthesized with the others, so that he ends in futility. Credit judgment is an art—not a science—and what the credit manager needs is some way of arriving at a composite on which he can say "yes" or "no."

M. R. Neifeld

Beneficial Management Corporation

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* Annual reports and publications presenting statistics collected at regular intervals have been omitted from this list. Some items of minor interest to statisticians have also been omitted. The contents of periodical publications are not listed, but the attention of the reader is directed to the lists of articles in current publications which are to be found in the *Revue de l'Institut International de Statistique*, *Journal of the Royal Statistical Society*, *American Economic Review*, *Population Index*, *Transactions of the Actuarial Society of America*, *The Record of the American Institute of Actuaries*, and *Sankhyā, The Indian Journal of Statistics*.—Editor.

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THE MEANING OF UNEMPLOYMENT STATISTICS*

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THIS IS THE end of a decade of estimating unemployment. The Census Bureau will soon issue its preliminary report from the Census of 1940.[1] We can then all re-examine and appraise the statistics we have been using for the past 10 years. Whether this initial Census report shows 7 or 8 or 10 or 12 million men and women unemployed in the spring of 1940, in itself matters little for the course of this discussion. Many of the same difficulties that all estimators have encountered in obtaining satisfactory statistical tools for the formation of public policy in this field will still remain, even after the 1940 Census has provided new bench marks.

The problem is how to go forward in the future with a program which will provide prompt, accurate, and useful measures of the amount of employment and unemployment and the size and characteristics of the labor supply. It is such a program that is here presented.

Let us begin with an examination of some of the widely used statistics of unemployment—those of the Congress of Industrial Organizations, the American Federation of Labor, and the National Industrial Conference Board, to name only three. In the spring of 1940, when the Census was taken, the C.I.O. showed 11.5 million unemployed, the A.F.L. 10.3 million, and the N.I.C.B. 9.2 million. In mid-October, after several months of a rapidly expanding defense program, they ranged from 8.9 million as reported by the C.I.O. down to 6.65 million from the N.I.C.B. Whether the Census proves them to be approximately correct or to be in error by 1, 2 or 4 million is not the primary problem.[2] The

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

[1] This report was issued on January 6, 1941, based upon a 5 per cent sample chosen by selecting 4 out of the 80 lines on each enumeration sheet, *before editing.*

[2] The tabulations indicate that in the last week of March 1940 there were 7.5 million persons seeking work or engaged in emergency work. The Census release calls attention to the fact that the number of emergency workers shown by the tabulations is about one million short of the number which would be expected on the basis of the records of the emergency work agencies. It seems probable that roughly half of these were enumerated as employed in private or regular government employment, because of confusion in the minds of the enumerators or because of the reluctance of emergency workers to report their status correctly. Most of the remaining misclassified emergency workers seem to have been reported as not in the labor force. The 472,000 recipients of N.Y.A. student aid no doubt accounted for a large part of this group, and most of them were probably reported as in school. Thus it appears likely that the total number of unemployed, defined as persons seeking work plus emergency workers other than N.Y.A. students, was about 8 million.

problem is this: Given the new bench marks from the Census of 1940, will revised estimates, continued along the same lines, yield satisfactory results 1, 3, 5 or 10 years from now, or can we devise other, improved statistical tools which will better serve purposes of public policy?

These three estimates and all of the others currently published use basically the same method. It is set up like a simple problem in subtraction. There is, first, an estimate of the total labor force, so-called, in this case, some variant of the familiar figure of the 48.83 million gainfully occupied from the Census of 1930, currently estimated in the neighborhood of 55 million. Second, there is an estimate of the total number of persons employed at any given time, in the spring of 1940 in the neighborhood of 43 to 46 million. We subtract: The remainder is so-called *unemployment*. That is, unemployment is a residual obtained by subtracting estimated employment from the estimated total labor force. If, then, there are errors in estimating the two large basic figures, they may well combine in the final estimate of unemployment to make a large percentage error in this much smaller figure. It has long been my opinion that unemployment estimated in this manner as a statistical residual has, and always will have, such great possibilities for error that this technique should be abandoned entirely and our combined efforts should be directed toward devising new and better methods for obtaining estimates of total unemployment. The reasons for this conclusion are given in more detail below.

In April 1930 all three key figures—the labor supply, employment and unemployment—were known. Great difficulties have been encountered in keeping these figures up to date. Many of these difficulties are still present and will be present after the Census of 1940 provides new bench marks.

The greatest difficulty, perhaps, is in the current estimates of the total labor supply. Starting with a figure for the gainfully occupied as reported in the Census of 1930, a current figure has been provided by estimating the population of each age group separately for men and women, and then computing the working population in each group. This is done, ordinarily, by assuming that the same proportion of men and women in a given age group were in the labor force throughout the decade as in 1930. The principal recognized exceptions are the very young and the very old workers, who are known to be less numerous; how much less numerous can only be guessed. Thus, the labor supply has been estimated to increase month by month and year by year by a fixed amount, on a straight line basis. Only the returns from the Census of 1940 can indicate whether the assumptions implicit in these fig-

ures were, in fact, justified.[3] It is likely, however, that estimates of the labor supply are far from satisfactory for two reasons:

(1) Because a great depression or any other major shift in general economic conditions will almost inevitably change the size and character of the labor supply. For the future, then, the question is whether, given the new Census bench mark for March 1940, estimators of unemployment will not almost immediately be in the same kind of difficulty they have been in for the past decade. Our tremendous defense program probably constitutes as great an upheaval for the American industrial system as the depression that began late in 1929, although it is of a different character. The ink will scarcely be dry on the Census figures before they are in fact so thoroughly out of date that we will again be only guessing if we apply the same techniques that have been used in the past and estimate labor force as a rising straight line. For example, during the World War period it has been estimated by the National Industrial Conference Board that employment exceeded by about 3 million their estimate of normal labor supply. This indicates the extent to which abnormal economic conditions may affect the size of the labor force.

(2) The second basic criticism of estimates of the labor force is presented by Mr. Myers. The change in the labor force is not constant or slow; it is very rapid—particularly from season to season within each year. Thus, for example, the effective labor force may change by as much as 3 million within a few months, as school children, housewives, members of farm families, etc., come and go from the active labor market. None of the current compilations of unemployment have estimated these changes nor could they possibly have done so. Yet for purposes of national policy in an expanding labor market, such as that of today, information on the size of the labor force is as important as information

[3] The Census figure of 52.8 million persons "in the labor force" is substantially smaller than would have been expected on the basis of the 1930 Census data. According to Mr. Loring Wood, of the Bureau of Labor Statistics, "This is the principal reason why the number unemployed was smaller than many estimators expected it to be. The discrepancy is pronounced even if comparisons are limited to the age groups 20–64 years, where the effects of the inclusion of inexperienced workers, decreases in child labor, and the trend toward earlier retirement, are largely eliminated. An adjustment of the 1930 figures to allow for changes in population and the expected increase in the proportion of women in the labor market would lead to an estimate for 1940 of 48.5 million "gainful workers" in these age groups—37.1 million men and 11.4 million women. The preliminary sample tabulations show 35.6 million men in the labor force, or 1.5 million less; and 11.2 million women, or 0.2 million less. Even in the more completely employed group of men aged 25 to 44, the discrepancy is substantial. While 97.5 per cent of the men in this age group were reported as gainfully occupied in 1930, the proportion in the labor force in 1940 was only 94.7 per cent.

"It is possible, of course, that there have been significant shifts during this decade in the proportion of the population which is, in reality, in the labor force. But such shifts probably were not large enough to account for the discrepancies noted, and it seems fairly certain that 1930 "gainful workers" and 1940 "labor force" cannot be regarded as comparable groups."

on unemployment, and a figure which may be in error by several millions is of little value.

There is, then, the second basis segment of unemployment estimates, namely, the figures of *employment*.[4] Estimates of employment in non-agricultural occupations have been made currently by the Bureau of Labor Statistics for some years. They are pieced together like a patch-work quilt from information from a great variety of sources. The total size of the employed group in the Bureau's figures and those of the agencies which estimate unemployment is initially determined from the Census of 1930, by subtracting the number of persons unemployed from the number gainfully occupied, with certain adjustments which vary according to the estimator.

Going forward, however, almost all of the existing data are reported by employers, not by the workman or a member of his family as in a Census enumeration. Consequently this 1930 total has been broken up into industrial segments, based upon industrial censuses or other comprehensive measures, leaving a residual to be divided up among the less well-organized and well-defined industries and occupations. The changes in these figures since 1930 are based largely upon changes in the number of persons on payrolls, as reported month by month by sample groups of employers in the more highly organized industries. For about 40 per cent of the working population there are fairly reliable current sources of information. For the other 60 per cent, including agriculture, the statistics are little better than informed guesses.

For manufacturing, mining, the railroads, the public utilities, much of wholesale and some of retail trade, hotels, some parts of finance and banking, part of the public construction industry, Federal employment, and certain other segments of industry, there are quite satisfactory monthly reports of employment to the Bureau of Labor Statistics, the Interstate Commerce Commission, the Federal Power Commission, the Maritime Commission and other agencies. These reports can be checked for general level, as the years go by, by comparison with the industrial censuses and adjusted to the reports of those censuses. Yet, as we all know, sizable errors have developed, even in some of these best-reported figures, such as manufacturing, because of the nature of the sample.

There remains, then, the 60 per cent of the working population for which current information on changes in employment is very unsatis-

[4] The 1940 Census total for employed persons, including the group not at work but with jobs, proved to be not seriously out of line with the estimates commonly used. The Census figure, however, includes 1.3 million persons who were reported as having jobs though not actually at work, some but not all of whom are included in current estimates as employed.

factory. It includes the very important private construction industry, state and local governments (until very recently at least), water and motor transportation, real estate and building management, all types of small stores and individual services, casual labor, domestic service, the professions and independent businesses, and agriculture. For these lines of work, information between decennial censuses can only be described as good guesses (or bad ones, as the case may be). It should be remembered also that there is no way of knowing when there is a net movement to or from these unreported industries into those for which reports are available. Thus, during the depression, there is reason to believe that many people who lost their jobs in factories or mines found means of living through performing personal services or starting small enterprises of their own, but because there was no way of measuring the number of such transfers it is not unlikely that there has been an under-estimate of employment and an over-estimate of unemployment during the depression. Now, the reverse is probably true; small individual builders, for example, may be going into the construction of army cantonments where their employment will be statistically reported for the first time. Employment will go up, unemployment will go down, although their transfer in reality means no net change in either figure.

For some of these formerly unreported occupations, current data are now becoming available through the Social Security Board, but there remains and will remain after the 1940 Census is complete a very large segment of the working population for which the method of direct reports on the number of employees at work for representative employers will never be satisfactory. Although great progress has been made in the past decade in the improvement of employment statistics, both with respect to the number of industries covered and the accuracy and representativeness of the reports, I think it must be recognized that we have pushed the technique of sample reports by employers about as far as it will go.

For these reasons, if we continue to follow the patchwork quilt method of estimating total employment as we have done in the past decade, we must expect continued errors of 1, 2 or more millions of workers. In a total employment figure of over 40 million this may not be of great importance if the *direction* of the change is correct. In estimating unemployment, however, if an error of 1 or 2 million in employment is added to another 1 or 2 million error in the estimate of the labor supply, the resulting combined error of 2 or 3 or 4 million may be very important in an unemployment estimate of 8 or 10 million. It may amount to as

much as 50 per cent. This is not imagination. We know that in the different seasons of the year an error of this magnitude is almost inevitable because of seasonal variations in labor supply alone, of which present estimates take no account. No set of figures with errors of this size can have much meaning.

Yet it is of the utmost importance to know and to know promptly and often—much more often than once in 10 years—how many people are unemployed. It is equally important to be able to relate unemployment to the size of the available labor force and the number who are at work. Guesses will not serve.

Moreover, even after these great global totals are obtained, we still need to know far more about the unemployed and the employed than we now know. Who are they? Are they the young or the old; are they experienced or inexperienced; are they in cities or in rural areas; are they merely laid off because of seasonal slack in their usual occupation; are they now actively looking for work; are they in hopelessly depressed areas? This kind of question can never be answered by building up dubious estimates of the total labor supply and subtracting equally dubious estimates of employment.

What, then, is the solution? I should like to propose not one set of statistics, but an entire battery of related information in order to answer the general question as well as a number of special questions which are so essential to sound formulation of public policy.

First, let us recognize that if we are to estimate the size of the labor force, the total number employed and unemployed, we must do so *directly* by a sampling technique, and abandon our present techniques. If we want to know whether a man is unemployed, we should ask him; we should not try to find him by subtraction. The public is now quite accustomed to the idea of sampling, thanks to the numerous public opinion polls, and statisticians are much more familiar with its actual limitations in social and economic fields.

I should like to suggest, therefore: First, a small monthly sample directly counting the unemployed, the employed and the persons in the labor force, using the Census of 1940 as a bench mark and following its general definitions. The valuable work in sampling for this type of information conducted by Mr. Howard Myers and Mr. John Webb of the Work Projects Administration should make it possible to put such a monthly system into operation quite soon after the 1940 Census data become available. If the sample is small, the collection can be prompt and the data will be sufficiently up-to-date to be really useful. In such a sample an urban-rural classification should be possible, and, on occa-

sion, a special question or two might be added regarding the characteristics of the unemployed.

Second, I should like to urge a comprehensive Census of Population, confined to a few basic questions, once every five years; and third, large sample enumerations by the Census Bureau once every two years. We should, by now, know the dangers of getting too far from base, if any kind of sampling technique is to be used.

Even such a valuable set of estimates of the labor force, of employment and unemployment will leave many questions still unanswered, merely because any comprehensive total provides only a general picture and necessarily conceals many diverse problems. In analyzing the unemployment problem, for example, it is important to know *where* the unemployed are and what kinds of skills and experience they have. The skill of the labor force becomes doubly important today in a rapidly expanding labor market. Such questions as these can best be answered through registration at the offices of the Bureau of Employment Security of the Social Security Board in connection with its work of placement and of payment of unemployment compensation. It is too costly and too slow to get information on skills and training by a census or by direct sampling techniques. Registration at employment offices will provide an adequate approximation for most purposes.

Moreover, as the Social Security system expands to take in other types of work and smaller firms, particularly for unemployment insurance, there will be many generally useful statistics as a by-product of its operations. Thus, the number of persons registered as unemployed and either receiving or awaiting unemployment insurance plus those who have recently exhausted their benefits will in itself be a measure of a very significant segment of employment. It will never measure total unemployment, because the coverage of the Social Security system is not complete, but it will indicate the direction of the change in the load of unemployment due to lay-offs by employers, and it will tell us much more than we now know about the location and the sources of *industrial* unemployment. Such a measure of unemployment is commonly used abroad; it is just developing here and we should all learn to use it.

With regard to *employment*, reports on changes in employment in the large industries which can be measured with some degree of accuracy are the best and most comprehensive of industrial barometers. Their importance should not be minimized. They are a key to the current changing industrial situation, particularly to the progress of the defense program. They should be made more complete and more precise by more critical analysis of reports from employers. But it seems clear that

we should concentrate our efforts in measuring employment by the method of reporting payroll totals in the fairly well-organized large-scale industries, where the employer-employee relationship is significant, and devise some new techniques (probably sampling) for finding changes in the number of self-employed and of persons engaged in small scale enterprise.

Lastly, a coordinated current analysis of all of the reports on employment and unemployment now at everyone's command, couched in terms which the ordinary man can understand, is badly needed. Most of all, after a decade of estimating unemployment, there should be a frank recognition of the inadequacy of the statistical tools in use for the past ten years. The Census of 1940 should be made a landmark for more satisfactory statistics in this field.

DYNAMICS OF LABOR SUPPLY*

By Howard B. Myers, *Director of Research*
Work Projects Administration

The subject of short-run changes in the supply of labor has been given far too little consideration by economists and statisticians. Attention thus far devoted to this field has been almost wholly turned, first, toward measurement of the volume of unemployment and of employment at a given time, and second, toward description of the characteristics of the employed and unemployed groups in cross section. In many discussions it has been assumed that the supply of labor, over short periods, is substantially fixed.

The reasons for this neglect are not hard to find. They relate mainly to the recency with which the need for such information has come to attention, to the absence of data on which a realistic description could be based, and to serious technical difficulties which stood in the way of securing such data quickly and accurately on a recurring basis.

The necessity for greater control of economic and social processes and the rapid extension of government into new fields of activity have brought a growing demand for current data regarding short-run labor-market fluctuations. This demand has been sharply stimulated by the defense emergency and by the frequently expressed fear that the labor supply may prove inadequate to meet the accelerating requirements of the rearmament program.

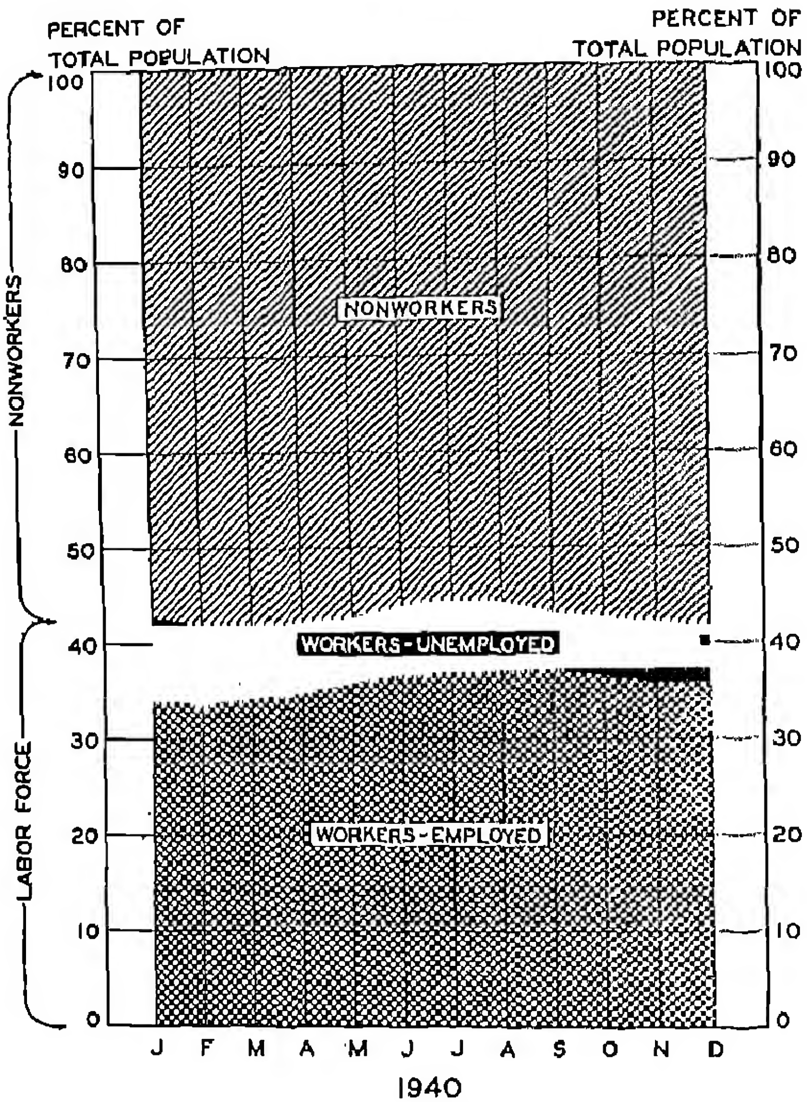
In recognition of the inadequacies of existing data the WPA started several years ago to work out a new approach to the problem of describing and analyzing the dynamic aspects of the labor market. In January 1940 the WPA initiated its *Monthly Report of Unemployment*, the first attempt by any agency to provide accurate measurements of unemployment, employment and the size of the labor force on a systematic basis.

In operation this survey uses the principle of the public-opinion polls. The superiority of the poll method results from the fact that labor-market activity is measured directly rather than estimated indirectly. The WPA survey interviews a carefully selected cross section of the total population. No additions or subtractions, based on assumptions as to unemployment reported in the census, net average increase in the labor force, or changing age structure, are necessary with the poll method; such assumptions are essential to all other methods. The result of

* Revision of a paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

CHART I

LABOR-MARKET STATUS OF TOTAL POPULATION
JANUARY-DECEMBER 1940
(Percentage Estimates)



Source: WPA Monthly Report of Unemployment

the poll procedure is an extremely fast and sensitive report on the state of the labor market that takes full account of changing conditions.

Each month a report is obtained concerning the activity engaged in during a specified week by each member of the sampled households who is 14 years of age or over. All such persons are asked whether they were at work, on emergency work, or actively seeking work during the week. These groups constitute the current labor force. Persons who are not engaged in any of these activities—that is, the nonworkers—are asked the reason for not seeking work. In addition to these items the schedule calls for information on certain personal and employment characteristics of the persons included in the sample.

The sampled households are selected at random within a group of sample counties chosen to be representative of the United States for the characteristics under observation. At the end of the year the survey was operating in 50 counties. Within these counties the sample covered approximately 20,000 households, including some 28,000 workers. The survey covers the week preceding the fifteenth of each month and estimates for the United States are completed before the end of the month in which the data are gathered.

A few of the findings of the survey will be presented briefly in this paper. While the period thus far covered is short, it is believed that certain conclusions may safely be drawn from the data already available.

Chart I and Table I classify the total population broadly according to the activities in which they were engaged during a specified week in each month of 1940. The employed and unemployed groups, taken together, constitute the labor force, which ranged roughly from 40 to 45 per cent of the total population during the period.[1] The remaining 55 to 60 per cent of the population is composed of nonworkers.

The major reasons for nonworker status were: Under 14 years of age, unable to work because of old age or handicap, engaged in housework at home, and in school. As is to be expected most of the nonworker categories exhibited considerable stability during the period. Students were an exception; this category decreased sharply during the

[1] As used in the survey the employed group includes persons 14 years of age or over who worked for pay or profit during the survey week in private or nonemergency government employment, or who had a job from which they were temporarily absent during the week.

The unemployed group includes persons 14 years of age or over who were not employed (as defined above) and were actively seeking employment, and those who worked during the week at public emergency work (WPA, NYA, CCC, etc.).

The sum of the employed and unemployed groups constitutes the labor force during the survey week.

These definitions are equivalent to those used in the 1940 Census of Population.

TABLE I

LABOR-MARKET STATUS OF TOTAL POPULATION*
JANUARY–DECEMBER 1940

(Percentage Estimates)

Month	Population	Labor force			Nonworkers
		Total	Employed	Unemployed	
January	100.0	42.5	34.2	8.3	57.5
February	100.0	41.7	33.9	7.8	58.3
March	100.0	41.6	34.3	7.3	58.4
April	100.0	41.8	34.9	6.9	58.2
May	100.0	42.4	35.9	6.5	57.6
June	100.0	43.7	37.0	6.7	56.3
July	100.0	44.3	37.0	7.3	55.7
August	100.0	44.1	37.2	6.9	55.9
September	100.0	42.8	37.3	5.5	57.2
October	100.0	42.5	36.7	5.8	57.5
November	100.0	41.9	36.0	5.9	58.1
December	100.0	41.9	36.2	5.7	58.1

Source: WPA Monthly Report of Unemployment.
* Figures subject to revision.

summer months, regaining approximately its former size as schools opened in the fall. The fact that the remaining categories changed little in total does not mean, however, that the individuals included all maintained the same status throughout the period. As will be noted later considerable amounts of cross-shifting by individuals occurred during the year.

Shifts among the worker groups were considerably more marked. Total employment rose sharply and rather steadily from February through September. Most of this increase and most of the subsequent decline were caused by marked seasonal changes in agricultural employment. The total employment increase from February to September was approximately 4.7 millions, of which nearly a third, or about 1.4 millions, had been lost by the end of the year.

Note, however, that the total labor supply also fluctuated sharply. Reaching its low for the year in March, the labor force rose to a peak in July, thereafter decreasing steadily through November. The labor supply increased by fully 3.8 millions during the four spring and early summer months. In the remainder of the year it decreased by about 3.2 millions, thereby losing nearly 85 per cent of its former gains.

The causes of these sharp fluctuations have not yet been fully analyzed. It is clear that a good share of the increase represents students who obtained work or were looking for work during summer vacations, and that a considerable proportion of the decline in the fall was caused by students leaving the labor market to return to school. It should be pointed out, however, that the great bulk of students dismissed from

school did not enter the labor market; most of this group went on vacation for the summer. Rural nonschool youth and seasonal agricultural and other outdoor workers constituted another important source of growth of the labor supply during the spring and early summer. Most of these were presumably engaged in or seeking farm work.

It should not be assumed that these additions to labor supply can be dismissed as of little consequence merely because most of them, or their equivalents, removed themselves from the market later in the year. In the first place, the data available indicate clearly that large numbers of them secured jobs, hence diminishing the effect of marked employment gains on the supply of previously unemployed workers. In the second place it appears quite possible that large numbers in this group would have remained in the labor market in the fall had jobs been available for them.

The volume of unemployment, including emergency workers, can be expressed as the difference between the total labor supply and the total volume of employment. Thus it is obviously affected not only by employment changes but also by increases or decreases in the total labor force. What were the net effects of the movements of both of these factors on unemployment during the year?

Starting at a high level in January, unemployment declined steadily through May, aided for most of the period both by employment gains and decreases in labor supply. Simultaneous gains in both employment and unemployment were reported for June, when a marked increase in the labor force more than offset the increase in employment. A further increase in unemployment was reported for July, followed by a decline in August. In September unemployment dropped very sharply, due primarily to the marked decrease in the supply of labor in that month. Unemployment rose in October and November, largely due to sharp losses in agricultural employment, and declined slightly in December primarily as a result of the stimulus of Christmas trade on employment.

The findings of the first year of the WPA survey serve as vivid illustration of the fact that the dynamics of labor demand have their counterpart in dynamics of labor supply. They demonstrate that the supply of labor, far from being fixed, in fact fluctuates sharply during short periods of time. They suggest further that estimates of unemployment lack realism unless they allow for rapid fluctuations in labor supply over and above the net annual increment to total supply. For example, during the period March–July employment increased by fully 3.8 millions. These gains, however, were almost exactly offset by increases in the supply of labor and as a result the volume of unemployment showed no change.

The national movements in employment, labor force, and unemployment which have been sketched are themselves the net results of a variety of geographical and urban-rural changes which often differ widely. As a single illustration we may take the changes occurring between April and May 1940. We shall divide the sample counties into, first, the counties containing the 5 largest cities of the country, second, all other counties with a total population of 45,000 or more in 1940, and third, those counties with a population of less than 45,000 in 1940. For convenience these groups will be called, respectively, metropolitan counties, urban counties, and rural counties.

TABLE II

LABOR-MARKET STATUS OF POPULATION IN RURAL, URBAN, AND METROPOLITAN COUNTIES*
APRIL–MAY 1940
(Percentage Estimates)

Urbanization group and month	Total population	Labor force			Non-workers
		Total	Employed	Unemployed	
United States					
April	100.0	41.8	34.9	6.9	58.2
May	100.0	42.4	35.9	6.5	57.6
Rural counties†					
April	100.0	37.7	32.0	5.7	62.3
May	100.0	40.3	36.4	4.0	59.7
Urban counties‡					
April	100.0	43.0	35.8	7.2	57.0
May	100.0	42.9	35.8	7.1	57.1
Metropolitan counties§					
April	100.0	47.9	39.5	8.4	52.1
May	100.0	46.3	37.6	8.7	53.7

Source: WPA Monthly Report of Unemployment.

* Figures subject to revision.

† Sample counties with a population of less than 45,000 in 1940.

‡ Sample counties with a population of 45,000 or more in 1940, excluding counties containing the 5 largest cities.

§ Counties containing the 5 largest cities: New York, Chicago, Philadelphia, Detroit, Los Angeles.

In the Nation as a whole employment increased between April and May, the labor force increased somewhat less, and unemployment declined. The so-called rural counties were entirely responsible for these changes (see Table II). In the rural counties employment rose very sharply, the labor force increased somewhat less rapidly, and unemployment decreased markedly. The situation in the metropolitan counties was exactly reversed; employment declined sharply, the labor force decreased by a smaller amount, and unemployment rose. The "urban" group of counties showed little change during the period either in employment, labor supply, or unemployment.

The changes in different geographic areas often are similarly diverse. The breakdown of national totals to show broad regional and urban-rural changes, age and sex shifts in the labor force, and changes in major industrial and occupational groupings provides a rich field for further experimentation and analysis of survey findings.

Thus far the movements discussed have all been net changes. These are the combined results of considerably greater numbers of changes in status on the part of individuals. Preliminary tabulations of survey data for the months of March and April, months in which identical households and persons were canvassed, serve to throw some light on the magnitude and direction of these shifts. The months selected were, on the whole, months of moderate change; they do not represent a period of extreme fluctuation.

Change of status during the two months has been measured in a forward direction, that is, in terms of the status in April of persons who had a specified labor-market status in March. The shifts reported are probably somewhat understated, since only persons who were in the sample during both months are included and since status was compared only for the two weeks of survey, thus failing to record a change for persons who changed status and then changed back between the March and April enumerations.

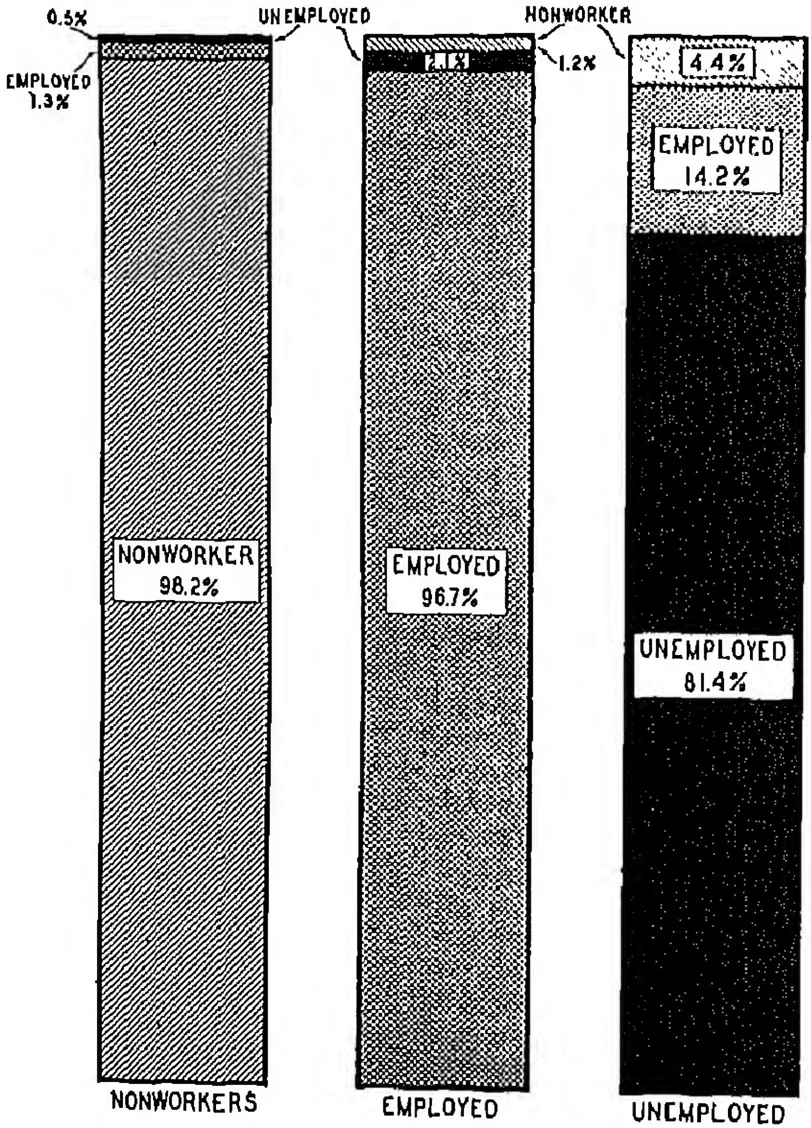
As Chart II and Table III indicate, 2 per cent of the nonworkers and more than 3 per cent of the employed group showed a change in status between March and April, while 19 per cent of the unemployed group reported such a change. In other words, about 1.4 million of the March nonworkers, 1.5 million of the employed, and 1.8 million of the unemployed changed their labor-market status during a period of 30 days. Although generalizations from a single pair of months are dangerous these figures do contain some interesting suggestions as to changes that take place in the labor force.

The 1.4 million nonworkers who had changed status by April had, of course, entered the labor market. As a very large part of the nonworker group is made up of children, housewives, and retired persons, it is surprising to find as much shift into the labor market during a single month as was reported. The figures suggest that the movement back and forth between worker and nonworker status is much larger than has been suspected. It is interesting to note also that approximately a million of the group which changed status went directly to employment; the remainder shifted to the status of unemployed.

Of the 1.5 million workers who were employed in March but had changed status by April nearly a million became unemployed. The remainder dropped out of the labor market.

CHART II

CHANGES IN LABOR-MARKET STATUS OF IDENTICAL PERSONS
MARCH–APRIL 1940
(Percentage Estimates)



Source: WPA Monthly Report of Unemployment

TABLE III

CHANGES IN LABOR-MARKET STATUS OF IDENTICAL PERSONS*
MARCH–APRIL 1940
(Percentage Estimates)

Status in March	Total	Status in April		
		Employed	Unemployed	Nonworker
Employed	100.0	96.7	2.1	1.2
Unemployed	100.0	14.2	81.4	4.4
Nonworker	100.0	1.3	0.5	98.2

Source: WPA Monthly Report of Unemployment.
* Figures subject to revision.

The most striking changes were reported for the unemployed group. Fully 1.8 million of the March unemployed changed their labor-market status during the month. It is encouraging that more than 1.4 million of these workers, or three-fourths of the total who changed status, had secured jobs. The remaining unemployed had left the labor market by April.

The data thus far presented all demonstrate that the labor force possesses a high degree of fluidity during short-run periods. It is apparent that seasonal changes in the size of the labor force are of the order of several millions of workers and that these fluctuations are the net result of a considerably larger number of shifts of status on the part of individuals. It seems clear that during the course of a year a much larger number of persons have been in the labor force than are employed or unemployed at any one period of time, and that there are large numbers who work or seek work during parts of the year and withdraw from the market at other periods.

Exact statement of the causes of these shifts must wait upon a great deal of further analysis. It is clear that one important cause is the closing of schools during the summer months, resulting in both permanent and temporary additions to the labor supply. Other shifts are caused by illness or accident, desire for retirement, changes in family income or family responsibilities, desire for further education, and so on. The decision of many persons to enter or leave the labor force probably is based largely on their judgments as to their market prospects—their chances of getting a job or of reemployment once a job has been lost, and the wages they may expect to receive. Some of these causes are pretty clearly seasonal in nature, others are probably related to cyclical fluctuations in economic activity, and some appear to be irregular in their influence.

There has been a great deal of discussion during recent years of the so-called "forced entries" to the labor market caused by the loss or dim-

inution of family income during the depression. Some such movement has undoubtedly taken place, but, as the foregoing discussion indicates, the net fluctuations in the labor force cannot be so simply explained. The factors which stimulate or delay entry to or exit from the market are extremely complex; a change in economic conditions which causes the entry of some workers into the market may cause the abstention or withdrawal of others. It appears that the total labor force tends, on the whole, to increase with both boom and depression conditions and to shrink in more normal periods, but available data do not provide a satisfactory basis for measuring the magnitude or timing of these movements.

In view of the surprising flexibility of the labor supply, and its tendency to expand and contract in accordance with demand, it seems probable that the sharp increases in employment forecast for the next year or so as a result of the development of the defense program will be accompanied by a considerable net increase in the active labor supply. Better employment opportunities and higher money wages should bring into the market considerable numbers of youth who have continued in school because they could not get a job, together with large numbers of out-of-school youth now dammed up on the farms because of the difficulty of obtaining employment in the cities. It appears probable, further, that many seasonal workers will remain in the market after their usual period of activity with the expectation of securing additional employment. In the short run, at least, these and other groups stimulated to enter or remain in the market should considerably more than offset the withdrawal of groups for whom better times provide an opportunity to leave the market and engage in other activities.

The normal net addition to the labor force is generally estimated at about 600,000 workers per year. This figure represents the excess of youth arriving at working age over estimated normal withdrawals from the labor force due to death or advancing age. It should not be surprising if the pull of better times coupled with the push of a near-war psychology results in an additional net influx to the market of several millions of workers during the next two or three years, over and above the normal growth. The scant evidence available suggests that an extremely rapid rate of influx occurred during the first World War.

It follows that caution should be exercised in translating estimates of probable increases in employment into estimates of probable future decreases in unemployment. The marked employment gains which are in prospect may well be offset in considerable part by sharp gains in the total supply of labor offered in the market.

WHOLESALE PRICE INDEXES*

By Francis McIntyre, *Indiana University*

The trend in price indexes is toward fewer such indexes, rather than more. Once it was fashionable for many firms to construct price indexes. Today the field is dominated not by the indexes of any private agency, but by a single index, prepared by a government bureau.

Why has this change come about? Largely through the improvement of index number technique. Lest that seem paradoxical, an explanation is in order. While index number formulas were of extremely simple pattern, and unweighted indexes were the rule rather than the exception, almost any enterprise could, at small expense, indulge itself in the luxury of maintaining its own index number, much as some financial institutions in the golden era kept economists.

Since Irving Fisher's impressive summary[1] of index number formulas a decade and a half ago there has been increasing emphasis on "good" and "bad" weighting systems. The opprobrium cast upon totally unweighted index numbers became too much to bear, and many have made a quiet exit from regular publication. Among those remaining the tradition for the Laspeyres formula became so strong that the only excuse for the competitive production of index numbers became a preference for a differing list of commodities (even the selection of weights seemed to be by acclamation) and others fell by the wayside.

In recent months we may have been witnessing the manifestation of another source of index number mortality—the lessened prosperity of financial publications. If the business of trading in the security markets is really as unattractive as recent quotations on exchange seats would indicate, many of the valuable services which the statistical departments of these publications have performed in the past are likely not to be available to the economist in the near future. Surely each of us shed a sincere academic tear at the passing of the well-remembered *Annalist*. We must be prepared for similar bereavements in the future.

The increasing dependence on governmental agencies as a source of published index numbers which the above-mentioned developments imply is not here viewed with alarm. The *raison d'être* of index numbers is surely the service they perform for a community of economists, in a very broad sense of that much abused term. It simply seems appropriate in this connection to note the source of supply.

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

[1] Irving Fisher, *The Making of Index Numbers*, (Houghton Mifflin Co., New York, 1927, 3rd Edition).

Important non-governmental general index numbers of wholesale prices of course continue. A by-no-means exhaustive list must include the weekly series of The National Fertilizer Association, the Babson Institute, the Index Number Institute, and the Journal of Commerce, as well as the daily series of Dun and Bradstreet and the Journal of Commerce. But the daily, weekly, and monthly indexes of the Bureau of Labor Statistics continue to be predominant, and in the remainder of this paper major attention will be paid them.

The daily BLS index is relatively new. Its reporting was begun only last year, and it is based on August 1939. Twenty-eight "sensitive" commodities are used, and an unweighted geometric mean of the price quotations is the index obtained. Released for publication weekly, this index is available daily by telephone or telegraph. While one is pleased to see the increased use of the geometric mean for such purposes, especially where weighting is believed to be impractical, this daily index is not a major product of the BLS statistical mill, and our discussions of formula and content should concern the much more extensive weekly and monthly series.

It is difficult to keep up with the number of price series the BLS index employs. Over quite an extended period of the 1930's it was about 784. A recent report mentioned 813. This is subject to change on necessarily short notice. It is difficult to know why so many series are used. The index has probably gained little in accuracy as a sample of all wholesale prices, merely by approximating a census of those commodities for which regular quotations are available. It is evident that sensitivity is not an objective, but merely in the interests of not exhausting the statistical facilities of the Bureau, some better criteria ought to be developed of how far it pays to push the inclusion of new price series beyond the point of diminishing returns.

A change in the method of construction of the BLS wholesale price index[1] took place about three years ago, which change was of much greater moment than any increase in the number of series. This is the abandonment, largely on the grounds of expediency, of the chain index method for the fixed base, variable multiplier technique.

The old method employed this formula:

$$I_i = \frac{\sum p_i q_w}{\sum p_{i-1} q_w} \times I_{i-1}$$

[1] Jesse M. Cutts and Samuel J. Dennis, "Revised Method of Calculation of the B.L.S. Wholesale Price Index," this JOURNAL, Vol. 32, No. 200 (December 1937) pp. 663-674.

where I is the index, i stands for any period, and w the period from which weights were obtained. With this formula a new series is added or an old one withdrawn by making the numerator and denominator of each link always include identical series. Thus for each month (say) there may be two aggregates. One will give the total of values appropriate to the preceding month, the other to the following month. The author has suggested elsewhere[3] that a commodity might be called *effective* in any month if its price for that month is permitted to affect the index for that month. Then each link may be written $L_i = \frac{\sum^{i} p_i q_w}{\sum^{i} p_{i-1} q_w}$ where both summations are taken over all and only over the list of commodities effective in period i. This process of keeping numerator and denominator of each link comparable is the only "correction" necessary when series are added or withdrawn. It would appear extremely simple, yet is objected to on the following grounds:[4] (1) Aggregates are not comparable over an extended period. This makes difficult the combining of price series into new groups. Since such combinations are frequently needed, the clerical work is heavy. (2) When a new price series is introduced under an old name (e.g., a change in the specifications of the article, but not in its common name) the old quantity weight yields a meaningless product. (The implicit assumption that the old quantity weight must be retained is not defended.) (3) The price multiplied by the quantity weight may give a meaningless product even without a substitution.

The second and third of these points may, it seems, be dismissed without much discussion. It may appear awkward or inconvenient to regard each change in a price series as the substitution of a new commodity for an old one, yet this is perhaps the only procedure certain to place in sharp relief the significance of altering the precise description of the commodity whose price quotation is employed.

There remains then the alleged difficulty of recombining the several commodities into different groups from those originally contemplated or constructed. That this may have presented a problem at some time in the past is of course possible, but modern statistical machinery would appear to reduce this operation to extreme simplicity. Presumably the price quotation is punched in one field of an electric accounting machine card, the appropriate quantity weight is punched in another, and the

[3] "The Problem of the Stock Price Index Number," this JOURNAL, Vol. 33, No. 203 (September 1938) pp. 557–563.

[4] Cutts and Dennis, *op. cit.*, pp. 665–666.

extension of their product is obtained electrically in a third field by means of a multiplying punch. If the desire to include differing grades or specifications under the same commodity name is irresistible, fourth and fifth fields may be used for price and quantity adjustments;[5] the sixth field should then display the original product (field three) plus or minus the product of fields four and five. This too is a simple automatic cross-footing operation for the multiplying punch.

Then when all the cards for month i are sorted together, the total of field three will be the denominator of L_{i+1}, the total of field six the numerator of L_i. A new commodity will have a blank field six on first appearance; a withdrawn commodity will have a blank field three on last appearance. Let us consider an example:[6]

Commodity: Currants. (No. 247)
Old series: Amalia variety. December 1936 price 11.0¢/lb.
Quantity weight 8215 (presumably the total
1935 marketings of currants in M lbs.)
New Series: Patras variety. December 1936 price 11.5¢/lb.

Now 8215 is justifiable only if 11.0×8215 makes sense for December 1936; i.e., if that product is the value of (say) 1935 marketings at December 1936 prices. If this is not the case, no selection of formula will help matters. This is a question of the validity of using Amalia currant prices as an average price for all currants, and has nothing to do with the appropriate correction for change to Patras currants.

The December 1936 card should then look like this:

			Field Numbers					
			#1	#2	#3	#4	#5	#6
1936	12	247	11.5	7858	90365.0	—	—	90365.0

and 7858 $\left(=\frac{11.0}{11.5}\times 8215\right)$ is the correct quantity weight until the next census. If, however, the substitution is made on the grounds that the Patras price is a better average than the Amalia for use in association with the quantity weight of 8215, this substitution should be handled as follows:

			#1	#2	#3	#4	#5	#6
1936	12	247	11.5	8215	94472.5	0.5	8215	90365.0

In neither case is the index for December 1936 affected.

[5] A simple adjustment procedure is illustrated below.
[6] Taken from Cutts and Dennis, *op. cit.*, p. 667.

To construct any desired new index it is necessary only to designate by code number the commodities one wishes to include, permit the collator to select those commodities whenever they appear in the cards for each month, and tabulate fields three and six for these cards, controlling on the month. The only clerical work required is a division to express each field six total as a ratio to the field three total for the previous month, and a chaining of these links by product cumulation.

The "improved" formula of the BLS index is a fixed base aggregative, $I = \dfrac{\sum p_i q'_w}{\sum p_0 q_w}$ in which the denominator is left alone, and compensating adjustments in q' are made whenever a correction must be applied to a price series. That this yields aggregates $p_i q'_w$ having no value significance is recognized, but not regarded as of importance. At this point I wish to register a sharp difference of opinion. I prefer what seems to me the simpler chain method on two grounds: Not only is it simpler, but it provides aggregates of price × quantity which are currently meaningful. Note that the final numerical results of the index computation are not at issue. I have shown elsewhere[7] that a systematic treatment of the corrections under the two methods will yield identical final index numbers.

One final remark needs to be made on the relation of index number theory to economic theory. Except for the field of price of living index numbers, and perhaps that of stock price index numbers, this relationship remains almost unexamined. The noteworthy exception in the case of price of living is due to a series of articles beginning in the *Review of Economic Studies* in 1935, and continuing through the literature for several years. The position was there developed that the problem of changing patterns of consumption and different lists of commodities at different dates would be solved if the commodities and weights were so selected that equal index numbers at different times indicated the individual still to be on the same consumption indifference curve, despite the changed composition of his market basket.

Now wholesale prices as a mass are so heterogeneous that I see no possibility of a parallel development, but there is a restricted class of prices for which theoretical tools are ready and waiting. These prices are the costs to producers of the factors of production, and the tools are the isoquants of the theory of production, as developed by Schnei-

[7] Alfred Cowles and Associates, *Common Stock Indexes 1871–1937*, (Principia Press, Bloomington, Indiana, 1938) pp. 26–30.

der, Carlson, and others.[8] An isoquant is the locus of factor combinations yielding a constant output. An index of production costs would be comparable at different periods if the commodities and weights were so selected that identical index numbers indicated the producer still to be on the same isoquant, despite the changed composition of his factor input.

The practical issue here is of course the need for the inclusion of services along with commodities in the price index. This lack is more serious than the objection (made against any proposed index of production costs) that every industry—even every plant—would require a separate index with a specialized list of commodities, services, and weights. Further, it must be emphasized that no criticism is due the Bureau of Labor Statistics because such an index happens not to be available. It is not supposed that the name "wholesale commodity prices" ought to be stretched to include productive services.

This is a problem not completely dissociated from current defense needs. With the cost of production looming more important daily, further study of it is essential. While the range of available production techniques may be quite different in different industries, variety is surely not as great as in consumption patterns, and a production cost index meeting these requirements for (say) heavy industry as a class ought not be entirely unyielding under the impact of this type of analysis.

[8] See especially Sune Carlson, *Studies in the Pure Theory of Production*, (P. S. King, London, 1939).

COST OF LIVING INDEXES*

By Robert A. Sayre
National Industrial Conference Board

In analyzing cost of living indexes it would seem most feasible to limit the analysis to a brief discussion of time-to-time indexes, i.e., indexes which measure changes in living costs from one period of time to another but do not measure differences in living costs between one place and another place. The two oldest and best-known national indexes, which have been available continuously over a long period of time, are the indexes prepared and published by the United States Bureau of Labor Statistics and the National Industrial Conference Board. The first to be made available for the United States was that of the Conference Board in 1918[1] and it was carried backward for selected dates to July, 1914; followed by that of the Bureau in 1919[2] which was extended backward to 1913.

Numerous changes have been made in the context, coverage, and publication dates of these indexes. The situation today is this: The Bureau publishes for each quarter indexes for the United States and 34 specified cities, Milwaukee having been added to these surveys in December, and preliminary interim indexes for each month beginning with October for the large cities of the United States and 20 of these cities at the request of the National Defense Commission.[3] The Bureau will shortly release quarterly indexes for 20 small cities and for cities with special problems arising out of the Defense Program and indexes of rents in Defense cities, also at the request of the Commission. The Conference Board publishes each month indexes for the United States and 56 specified cities.[4]

The Bureau has recently revised its indexes from 1935 to date[5] and has placed them on a 1935–1939 = 100 base in line with the recommendations of the Central Statistical Board. The indexes for earlier years were linked to the new series, taking the new major budget group weights into consideration in the linking process since 1925.[6] Now, the

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

1 "Wartime Changes in the Cost of Living," National Industrial Conference Board, *Research Report No. 9*, August 1918.

2 Hugh S. Hanna, "Summary of Increased Cost of Living, July, 1914, to June, 1919," U. S. Bureau of Labor Statistics, *Monthly Labor Review*, October 1919, p. 7.

3 *Monthly Labor Review* and press releases.

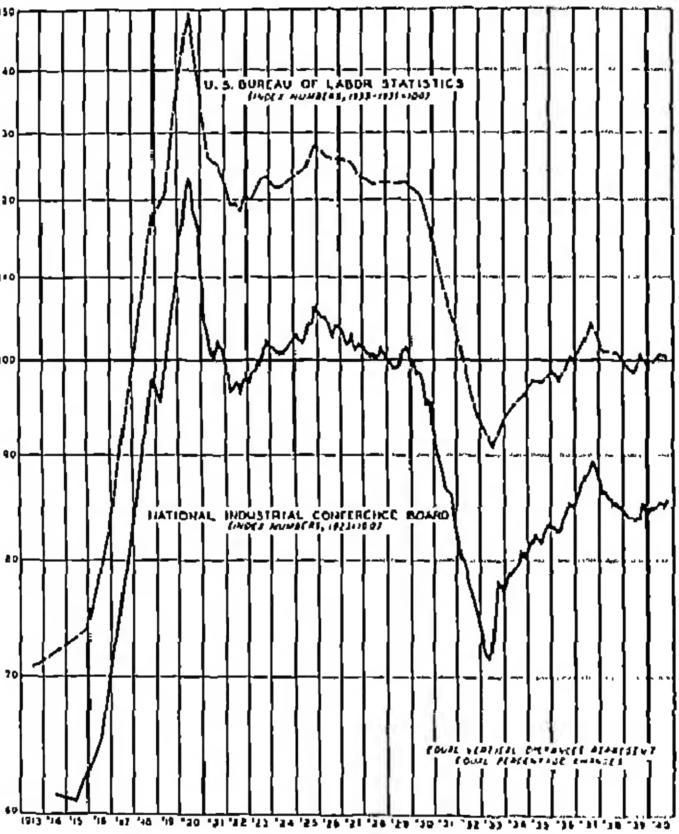
4 *The Conference Board Economic Record*.

5 Prepared by Cost of Living Division, Dr. F. M. Williams, Chief, "The Bureau of Labor Statistics' New Index of Cost of Living," *Monthly Labor Review*, August 1940, pp. 397–404.

6 *Ibid.*, pp. 392–404.

Conference Board index for the United States is on a 1923 = 100 base but is in the process of revision and shortly will be related to a more recent base period. Its indexes for 56 cities are on a January 1939 = 100 base. The two indexes for the United States are compared in Chart I.

CHART I
COST OF LIVING INDEXES
UNITED STATES, 1913-1940



That of the Bureau represents the new index since 1935 with the old index linked on for earlier years. All these indexes are compiled, in a sense, by the aggregative method. Under this method, all the items purchased by families of wage earners and lower-salaried clerical workers would be priced each period and the aggregate cost would then be related to the aggregate cost in the base period to obtain the index. Actually, however, the procedures followed are different. These differences will be discussed only briefly since they are merely expedients nec-

essary to make the aggregative method more flexible. They provide for sampling rather than for complete coverage and for changes in the sample of reporters and of items priced.

Both agencies report indexes for a similar number of categories of purchases, namely, all items, food, housing, clothing, fuel and light, housefurnishings, and sundries. The exception is that the Conference Board index includes housefurnishings under sundries. When revised, this index will also show housefurnishings separately.

The various steps involved in the compilation of the indexes are complex and involve many refinements of method. They do, however, spring from certain basically simple concepts. In each period, both organizations collect from retailers throughout the country retail prices of a long list of commodities. The method of collection, of course, varies. Through its retail price division, the Bureau sends field workers to the 34 cities and depends upon these workers to collect nearly all of the prices which go into its indexes. The Conference Board collects the major portion of its prices by the questionnaire method. In other words, questionnaires are mailed to retailers in nearly 200 cities, who in turn record prices on them and send them back to the Conference Board. While the Bureau covers the complete list of selected budgetary items in each of the 34 cities, the Conference Board does not cover all selected items in all of the nearly 200 cities. It does, however, cover all selected items in 70 cities, for 56 of which it publishes city indexes.

Since the two organizations compile their city indexes by somewhat similar methods, they will be discussed first and the United States indexes later. This mass of retail prices is assembled by cities by budgetary groups. Prices of individual items in a city are then averaged in any given month. From this point on, the compilations follow different paths, reaching, however, the same end. The Bureau calculates the percentage changes in these average prices from those in the previous period, using an identical sample of items and outlets, and applies them to the estimated costs of each item in the previous period to obtain costs in the current period. A grand total and totals by budgetary groups are computed. These totals are related to the totals in the base period to obtain the indexes. Under this procedure, the Bureau applies price ratios to basic expenditures by wage earners and lower-salaried clerical workers to secure cost aggregates for each pricing period.

On the other hand, the Conference Board compiles the average prices of the individual items for two successive months from identical establishments. These prices are weighted by the typical quantities purchased and aggregated by budgetary groups. Thus data are obtained for a pair of months from an identical sample. The change in this sam-

ple from the preceding month to the current month is then applied to the index for the preceding month to obtain the index for the current month. The resultant group indexes are weighted by a percentage distribution indicative of typical purchasing, to obtain the total cost of living.

The weighting systems employed are derived from the annual purchasing habits of consumers representative of the city for which the index is constructed. In other words, different weights are used for different cities. Thus, if the cost of living rises 1 per cent in Boston and 2 per cent in New York, it does not mean that the same commodities rose more in price in New York than in Boston, but that the cost of commodities usually purchased each year in New York rose more than those usually purchased each year in Boston.

These weights were derived from recent studies of the annual purchasing habits of actual consumers—that is, families of wage earners and lower-salaried clerical workers—in many cities. The most recent and comprehensive studies of this type are the *Money Disbursements of Wage Earners and Clerical Workers* and the *Studies of Consumer Purchases, Urban Series,* conducted by the Bureau of Labor Statistics with the assistance of the Works Progress Administration during the period 1933–1936.[7]

Turning now to the United States indexes, that compiled by the Bureau is a composite of its city indexes weighted in accordance with the population of the metropolitan area of each city plus adjacent metropolitan areas and cities having over 50,000 population in the same region considered to be subject to similar price movements.[8] The Conference Board index for the country as a whole is compiled directly from the Bureau's index of retail food costs and from the retail prices of other items collected by the Board and does not as yet employ weighting factors based upon the new budgetary studies.[9] When the revision of this United States index is completed, however, it will be a composite of city indexes and will continue to take into consideration data collected from the other cities for which no city indexes are now being published. Likewise, the new composite of city indexes will be weighted on the basis of population. Preliminary calculations reveal that the Conference Board's revised index, like the Bureau's, will show no marked variation from the old index.

[7] Faith M. Williams and Alice C. Hanson, *Money Disbursements of Wage Earners and Clerical Workers*, U. S. Bureau of Labor Statistics, Bulletins Nos. 636, 637, Vols. I and II, 639, and 641; A. D. H. Kaplan, Faith M. Williams, and Mildred Hartsough, *Study of Consumer Purchases, Urban Series*, U. S. Bureau of Labor Statistics, in cooperation with Works Progress Administration, Bulletins Nos. 642, Vol. II; 643, Vol. II; 646, Vol. II; 647, Vol. II; and 648, Vols. II, V, and VI.

[8] *Monthly Labor Review*, August 1940, *op. cit.*, pp. 380–388; and September 1935, pp. 828–830.

[9] National Industrial Conference Board, *Cost of Living in the United States, 1914–1936*, pp. 13–42.

Digressing for a moment, attention should be called to a source of misinformation about the Conference Board's index for the United States. The *Encyclopaedia of the Social Sciences* in an article on the cost of living by Dorothy W. Douglas[10] discusses the construction of the Conference Board index. This material was copyrighted in 1930, and, at the time of publication, was correct; but within a few months it was incorrect because of revisions made in the index.[11] No changes have been made in this article; all reprints of the *Encyclopaedia* have apparently been made from the original plates. This merely indicates the difficulties which may arise from using secondary source material.

So much for the construction and coverage of these indexes. The last two points to consider are their usefulness and improvements which might be made in them.

To my mind, cost of living indexes perform a threefold task:

1. They measure changes in the cost of living.
2. They show changes in purchasing power.
3. They are useful in determining time-to-time changes in wage or salary levels, but not place-to-place changes.

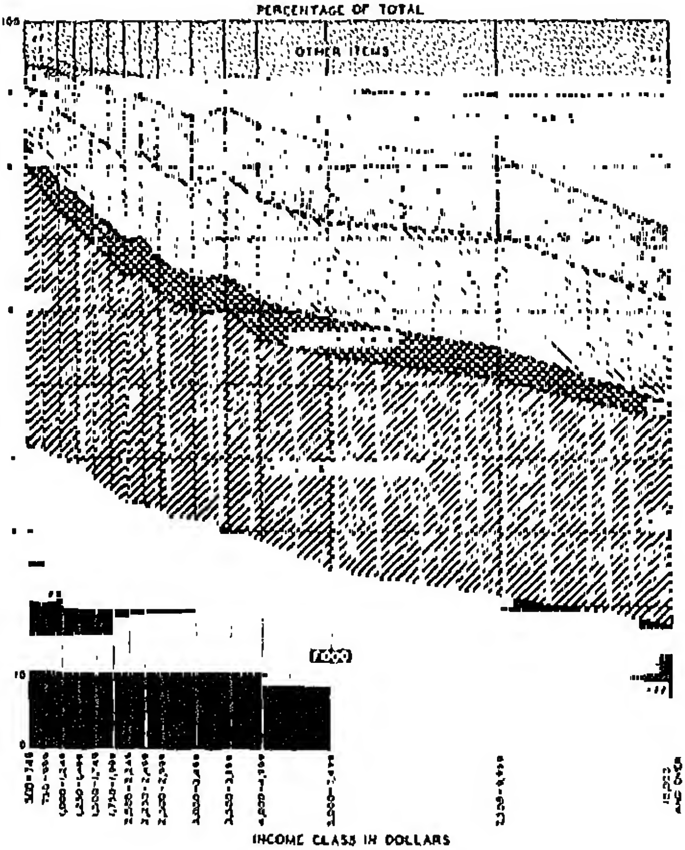
The indexes of the Bureau of Labor Statistics and the National Industrial Conference Board, as indicated by the methods used in their construction, do measure changes in the cost of annual living in any given period of time for a workingman and his family and for a lower-salaried clerical worker and his family. Typical purchasing by this group is the basis of the indexes. These indexes do not measure changes in the cost of living for those in higher income brackets and should not be considered to do so. True, costs for all people tend to move in the same general direction over long periods. It is probably reasonable to say that, if these indexes rose 15 per cent in *X* years, the chances are that living costs of people in the $10,000 income class, or any other, likewise rose appreciably. The inclination, however, to apply month-to-month movements in the indexes to people for whom they were not intended could conceivably lead to false conclusions. For example, on numerous occasions, living costs rise or fall principally because of changes in food prices, other items in the budget remaining relatively stable. Of course, food costs are a considerably smaller proportion of the expenditures of the higher income recipients and, hence, even if the foods purchased by these people rose by the same percentage as those purchased by the wage earner and lower-salaried clerical worker, the increase in total living costs would be appreciably smaller. Indeed, the increase which

[10] Dorothy W. Douglas, "Cost of Living," *Encyclopaedia of the Social Sciences* Reissue of November 1937, Volume II, pp. 478–483.

[11] National Industrial Conference Board, *Cost of Living in the United States*, 1914–1930, pp. 35–43.

seemed large on the basis of the indexes might actually be so small, when weighted in accordance with their importance in the budget, for the other group as to have virtually no significance.

CHART II
DISTRIBUTION OF MONEY EXPENDITURES FOR FAMILY LIVING
CHICAGO, 1935–1936



Source: "Family Expenditure in Chicago, 1935–1936," Study of Consumer Purchases, Urban Series, Bureau of Labor Statistics-Works Progress Administration

As indicated in Chart II, the consumer purchases study for Chicago[12] shows, for example, that in 1935–1936 food accounted for 42 per cent of the expenditures of $500–$749 income class but for only 17 per cent

[12] A. D. H. Kaplan, Faith M. Williams, and Mildred Hartsough, *Family Income and Expenditure in Chicago, 1935–1936, Volume II, Family Expenditure*, U. S. Bureau of Labor Statistics, in cooperation with Works Progress Administration, Bulletin No. 642, Vol. II, p. 11.

of those of the $10,000 and over income class. Similarly compared, clothing and personal care rose from 8 to 14 per cent, contributions and personal taxes from 1 to 19 per cent, and miscellaneous items from 5 to 10 per cent. Home maintenance, on the other hand, dropped from 38 to 28 per cent between the two income levels.

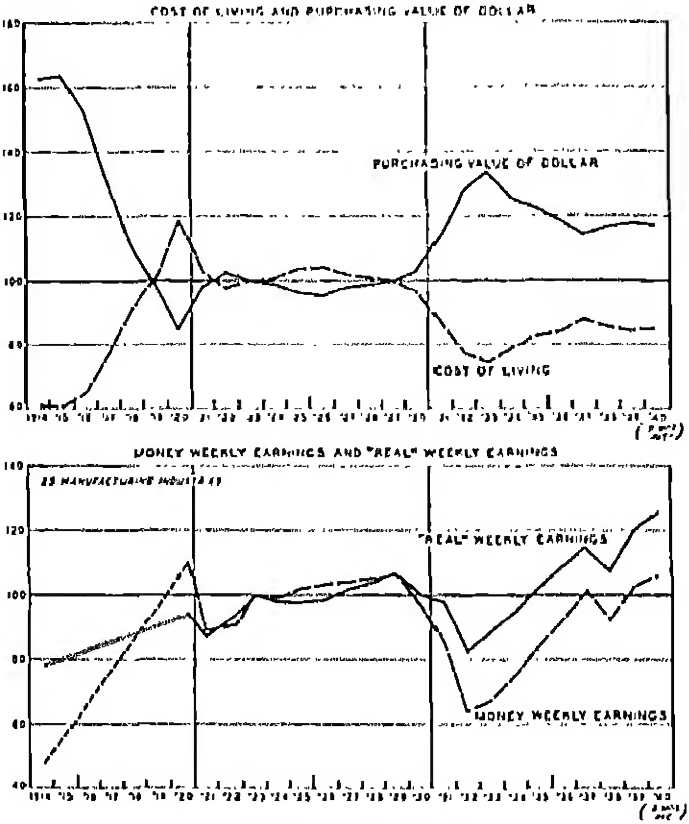
Perhaps the most evident reason against using these indexes outside their field is that the higher the income the more diversified the spending habits. Hence, the less typical any index becomes. When income is relatively low, people are limited in the variety of things they can do with their money because they must first eat, have shelter, and be clothed. In contrast, higher income brackets spend a much smaller proportion of their incomes for these necessities, and considerable amounts for optional items. Out of total estimated expenditures in 1937 of 71 billion dollars, 54 billion went for ordinary items and only 17 billion for luxuries.[13] When you consider that these data include spending by all the people, you can readily understand that the luxury segment would rapidly shrink if the estimates were confined to the wage-earner-lower-salaried-clerical group. A comparison of optional spending with subsistence spending between 1909 and 1937[14] reveals that, despite the fact that optional spending has grown over the years, in 1937 only 56 per cent of per capita expenditures by all the people represented reasonably free exercise of choice; 44 per cent was necessary for subsistence. Similarly, if these figures were confined to the lower-income workers, the percentage of subsistence spending would be considerably augmented. The standard of living of wage earners' families has improved over the years as indicated by available budgetary studies.[15] In 1869–1879, food absorbed over 51 per cent of the expenditures of these people while miscellaneous items accounted for only 11 per cent. In contrast, by 1930–1935, food had dropped to 33 per cent and miscellaneous items had risen to 35 per cent.

The second task of cost of living indexes, measuring changes in purchasing power, is quite easy. The purchasing value of the dollar is simply the reciprocal of living costs. If living costs rise, it follows that the purchasing value of the dollar declines. If the desire is to measure changes in the purchasing power of a particular wage group, sometimes referred to as "real" wages, the wages can readily be divided by the cost of living index to eliminate the influence of changes in these costs. Chart III compares annual data of the Conference Board's indexes of the cost

[13] National Industrial Conference Board, *Road Maps of Industry*, No. 235, June 28, 1940.
[14] Derived from *Conference Board Studies in Enterprise and Social Progress*, pp. 139, 144, 147.
[15] *Ibid.*, p. 153.

of living and of the purchasing value of the dollar from 1914 to date. The chart compares money weekly earnings with "real" weekly earnings in 25 manufacturing industries,[18] i.e., money weekly earnings adjusted for changes in living costs.

CHART III
PURCHASING VALUE OF DOLLAR AND OF WAGES
UNITED STATES, 1914–1940
Index Numbers, 1923 = 100



Source: The Conference Board

The third and last task involves the use of these indexes in determining wages or salaries. They are useful in making changes in wages or salaries from time to time within a group. If you assume that the wage level today for machinists or shipping clerks, for example, is correct, changes in the indexes may be considered as one measure of when wage

[18] National Industrial Conference Board, *Wages, Hours, and Employment in the United States, 1914–1936*, and subsequent publications.

or salary adjustments may become necessary for these workers. If the cost of living rises 5 per cent, it may be desirable to raise machinists' wages 5 per cent. Indeed, there are union contracts in force today which specify that a fixed percentage change in living costs will be accompanied by a fixed change in wages.

What has been said so far might seem to indicate that these indexes are performing their function and are above reproach. This is not quite true. I believe that they suffer from two important weaknesses, one of which is more apparent than real, and the other of which does not lend itself to correction.

The first is the infrequency with which budgetary studies are conducted. Prior to the 1933–1936 Money Disbursements and Consumer Purchase Studies of the Bureau of Labor Statistics and the Works Progress Administration, and since 1918, only a few investigations of purchasing habits of consumers were made. Such a survey in 1918–1919,[17] made by the Bureau, was used until recently by it to determine weights and to select commodities for pricing. Other surveys conducted in the period 1921–1929 were used by the Conference Board[18] as the basis for the revision of its index made in 1931 and carried back to 1914. It is quite true that these earlier studies became definitely out-of-date but continued to be the basis of the indexes until recent months. You are, of course, familiar with the revisions in the Bureau's indexes which have been published. Details of those in the Conference Board indexes have not been completed and, hence, have not been published. As might be expected, the Bureau's new indexes differ only slightly from the old indexes.

I feel, therefore, that although new budgetary studies result in little change in the indexes, they should be made frequently, say every five years, and certainly not less frequently than every ten years, since they provide the basis for corrections in weights and in items priced. In this way doubts as to the accuracy of the basis of the indexes will be eliminated. Infrequent studies cause such doubts to rise and to magnify in the minds of persons interested in changes in living costs. There is no other way to dispel these doubts than to prove by actual surveys and calculations that the indexes are representative. Unfortunately, however, complete budgetary studies are exceedingly expensive. Until new and less costly methods are devised it is improbable that comprehensive studies will be made as frequently as they should be.

The other principal weakness lies in the fact that at each period the indexes measure changes in the cost of annual living. Such procedure

[17] *Cost of Living in the United States,* U.S. Bureau of Labor Statistics, Bulletin No. 357, May 1924.
[18] National Industrial Conference Board, *Cost of Living in the United States, 1914–1936*, p. 42.

fails to account for variations in purchasing habits due to the effects of the season, or shifts in the season, and to unusual conditions. Imputed annual consumption of fresh green beans by families of wage earners and lower-salaried clerical workers in this country is about 9 pounds.[19] But, fresh green beans are expensive in winter and inexpensive in summer. By imputation, about 80 pounds of onions are consumed each year.[20] They appreciate in the winter much less than fresh green beans since they can be readily stored. Hence, it is reasonable to suppose that a large proportion of the annual consumption of fresh green beans is purchased in the growing season and that the major portion of the annual purchase of onions occurs in the winter months when they are relatively cheap. Likewise, electricity is used in varying amounts in the different seasons. You might say, find out seasonal purchasing habits and shift the weights in your index to allow for this. In conducting the Money Disbursements Studies, the Bureau of Labor Statistics did study food purchasing habits in a typical week for each of the four seasons.[21] It would seem that here at least would exist a basis for eliminating the effects of the season. But it would also introduce a heavily weighted factor of seasonal shift. Suppose that spring is late and a drought is severe in the truck crop belt. Fresh green beans would be scarce and expensive. But we would be assuming that purchasing would be the same as if spring had come at the usual time and there had been no severe drought. Introduction of seasonal weights would, therefore, eliminate one difficulty and introduce another just as important. Price changes because of accidental happenings would distort any index, be it on an annual or on a seasonal basis. In other words, there seems to be no way to make allowance for changes in purchasing habits caused by fluctuating prices. Too many factors influence price, most of which cannot be measured with accuracy on a quantity basis.

In conclusion, I believe that the cost of living indexes prepared by the Bureau of Labor Statistics and by the Conference Board are good indexes, so long as it is understood that they measure time-to-time changes in prices of annual purchases, and their use is confined to the economic groups whose living costs they were intended to measure. They would be improved by more frequent budgetary studies; and by the use of seasonal weighting systems if these were feasible.

[19] Stella Stewart, Chief, Retail Price Division, and Faith M. Williams, Chief, Cost of Living Division, *Retail Prices of Food, 1923–1936*, U. S. Bureau of Labor Statistics, Bulletin No. 635, Table G, pp. 182–183.

[20] *Idem.*

[21] "Money Disbursements of Wage Earners and Clerical Workers," any bulletin in this series, Appendix F.

PRICE INDEXES AS VIEWED FROM THE STANDPOINT OF THE NATIONAL DEFENSE PROGRAM*

By Martin Taitel, *Economic Consultant, Price Stabilization Division, National Defense Advisory Commission*

The most vivid pictures of our economy during the World War period are those of the price-profit-wage spiral of inflation. These pictures have, in the main, been drawn in terms of price movements largely because there is a greater abundance of data on prices for that period than on profits, wages, production, and so on.

So dramatically have the evils attendant upon the spiraling of incomes and values been painted in terms of prices that in some quarters the tendency has developed to consider the abolition of price increases as the goal of price policy. The schematic outline of the thought process is something like this: (1) the evils of inflation must be avoided, (2) price increases give rise to inflation, (3) the elimination of price increases will prevent the evils, (4) ergo, prices must not be permitted to increase.

When the attitude toward economic problems is that the goal is rigid prices, then the questions which bedevil the economist and statistician are: At what levels should prices be fixed? What indexes should be used as guides? Should there be attempts to stabilize a particular price index? If so, which one? If not, should the levels and relations between various indexes be fixed? These are the kind of questions upon which attention becomes focused when price control is considered to be the price job required by a defense program.

Clearly such an approach detaches prices from the myriad of other factors in market situations and places them in a realm of their own. Technology, costs, supplies, trade practices, geography, and so on are considered only at a later stage when the practical questions of when, how, and at what levels controls are to be invoked, have to be faced. But, by this time, the market factors other than price have become difficult or impossible to affect, so that either price fixing without regard to them is necessary or prices must be set at undesirable levels.

The whole approach to prices from the standpoint of price control is much too narrow because price control in and of itself does not provide the most important reference points which must be the guides to policy and action. The real perspective toward prices and price policies can only be obtained from a clear notion of what the job of national defense is.

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

The national defense program is designed to achieve very concrete objectives. Primary among these is the expansion of production and productive power, not only in the area of military equipment and supplies, but also in the area of goods and services for the civilian population. Military requirements, of course, take precedence, but, to the extent that our productive power permits, output for civilian use is to be expanded. In short, the goal of the defense program is a vigorous efficient economy operating at high levels of production, both military and civil; and, of course, an economy organized and operated within the tenets of a democracy.

It is with reference to this conception of the national defense program that questions as to the use, adequacy, improvement, and development of price indexes have a relevant locus.

As far as the purely technical aspects of price index construction are concerned, the problems and considerations are the same when the indexes are to be used under a defense program as they are when the indexes are to be used under normal peace-time conditions. Of course, prices rather than price quotations are to be obtained; of course, items and weights most appropriate for the purpose in mind are to be used; and so on down the line of all those things which constitute a technician's nightmare in the price index field.

The use to which price indexes can be put under a defense program depends at heart upon the conception of the function of prices in the attainment of the objectives of the program—upon the attitudes and policies toward prices.

While the policies toward prices under the defense program have not as yet jelled, the broad outlines have been fairly clearly indicated. Broadly, the objectives are (1) to provide a reasonable degree of stability of price levels, (2) to provide for flexibility, down as well as up, of individual prices so long as such prices remain within bounds, and (3) to provide a balanced price structure or relationships between prices which are conducive to balanced and expanding flows of production from and incomes to the various groups in the economy. But these objectives are sought, not as ends in themselves but as the means to the real end—national defense.

Price structure and the broader movements of prices are considered as strategically important factors affecting both the level and the distribution of resource use. Prices are considered as major determinants of the income distribution and thereby of the pattern of expenditures which in turn determines not only the distribution of output but also the total output.

So far as the level of prices is concerned, the conception is that a reasonable degree of stability is essential for the orderly conduct of economic activities. The importance of price level stability has impressed itself upon the Nation so deeply that one can almost use interchangeably the statements of all groups in the economy from the most conservative to the most radical.

I quote here from a statement of one of the conservative groups, the United States Chamber of Commerce:

> Violent price fluctuations cause strains and dislocations in the country's economic processes and result in hardships for business, labor, and consumers.
>
> Thus, the long-term interests of everyone in prices are identical.
>
> In connection with the defense efforts of the government, business men have firmly and consistently declared their intention to do everything within their power to prevent price increases that may not be justified.

Within the price structure, of course, flexibility is desired—flexibility, that is, in the sense of ease of adjustment to fundamental changes in market conditions, but not in the sense of erratic and gyrating fluctuations in answer to speculative or even manipulative activities. Under conditions of accelerated production and of marked changes in the product-mix, all those factors which make price flexibility necessary in peace-time developments are accentuated. And this makes it even more important that prices be flexible during the present emergency than during other periods.

With respect to individual prices, to an audience of statisticians, one may best indicate the general attitude by saying that price is considered the dependent variable and not the strategic independent variable. And, consequently, attention is focused on the factors affecting price rather than upon price *per se*.

This attitude or approach is sharply different from that of the World War period. *Then* price was thought of as the prime mover of production and capacity expansion. A perusal of the minutes of the price-fixing committee of the World War period shows this quite clearly.

Under the present defense program, however, expansion of supply, production, and capacity are attained in large measure by working on factors other than price. Or, if expansion is impossible, either immediately or eventually, then techniques other than price changes are used to determine who gets the available supplies or output.

However, should these procedures fail of their purpose and should it seem likely that prices are about to start an upward spiral, it is quite

probable that more direct procedures will be used.[1] There seems to be no intention on the part of those in charge of the defense program to permit run-away price movements. While they are not desirous of using strong-arm methods, they are determined to attain their objectives in the price as well as in other areas.

The present attitude toward prices can best be illustrated by a few specific examples of the way in which the price problems arising in various sectors of the economy have been met.

Sugar. Import quotas were suspended and later restored—and this it may be noted occurred prior to the establishment of the Defense Commission.

Copper. Conferences were held to discuss probable requirements, supply, production, and capacity, to crystallize the nature and scope of the supply problem, and to canvass the possibilities for obtaining adequate supplies without price disturbances. The result of these conferences and of studies made by the Defense Commission indicated that a probable shortage of copper in 1941 could most satisfactorily be met by the importation of South American copper. Recently, as most of you no doubt noted, the Metals Reserve Company has contracted for 100,000 tons of such coppper. And, of course, careful study is being given to methods of expanding domestic capacity should this become necessary later.

Steel. The initial step was export control of certain grades of steel scrap. Later the export-licensing controls were extended to cover all scrap and some steel products as well. More recently arrangements have been made for the importation of coke from Britain. Furthermore, in steel—as in other areas—the Government stands ready to provide suitable financial guarantees in order to obtain expansion of facilities. And, finally, for the purpose of enhancing the steel scrap supply, certain reductions in freight rates on scrap have been proposed as a more desirable change in the price structure than further increases in scrap prices because excessive rises in scrap prices act as a lever on steel prices.

Lumber. This is a case in which prices have not behaved satisfactorily and in which prices are still at unreasonably high levels. Dissemination of market information was used in order that interested parties would be conversant with the fundamental underlying conditions. Recently Commissioner Henderson has pointed out that high lumber prices en-

[1] Since this paper was delivered, direct price controls have been applied in a few cases. As of April 5, maximum ("ceiling") prices have been established as follows: Second-hand Machine Tools (February 17, 1941); Aluminum Scrap and Secondary Aluminum Ingot (March 21, 1941); Zinc Scrap Materials and Secondary Slab Zinc (March 31, 1941); Bituminous Coal (April 2, 1941); Iron and Steep Scrap (April 3, 1941).

courage the use of substitutes for lumber so that the industry has much to lose in too high a price, since markets lost to substitutes take years to regain.

Tin, rubber, and *manganese.* In order to insure adequate supplies at reasonable prices, stockpiles of these, and of other materials as well, are being accumulated—in some cases at prices below the world market.

In other cases, research in the development of substitutes is in process. There has been little need for the use of substitutes to date, but this research is being carried on so that in the event of necessity shifts to substitutes can be made. And in still other cases, as the need arises, demand may be restricted by the use of priorities.

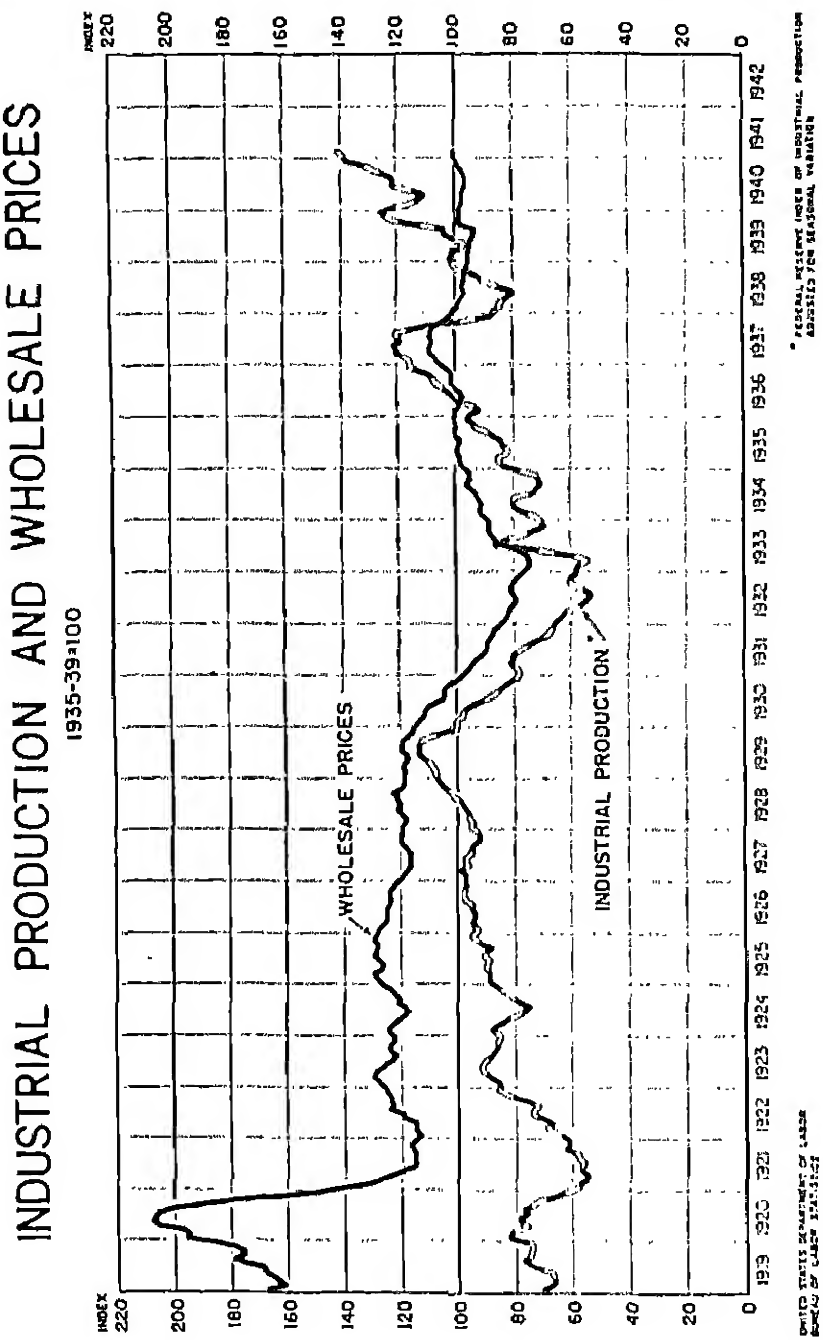
Price, it is clear from these illustrations, is considered more as a resultant than as a prime mover in the productive process. Emphasis is upon supply and demand in the sense of expanding production, capacity, and imports, of curtailing exports and arbitrary withholding or cornering of markets, and, in the last resort, of limiting demand in what are for the duration of the emergency the less important sectors of the economy.

Success under this type of approach necessitates constant watch of markets. Price data provide only part of the needed information; inventories, capacities, production and so on must also be kept under surveillance. But because of the more immediate availability of price data they are most likely to provide the initial clues to underlying market conditions.

From what has been said it may appear that price indexes are not very important in the practical operations of the defense program relating to prices. Yet this is far from the fact. It just happens that, leaving aside the overall monetary and fiscal controls, action in the price field must be specific with respect to a particular commodity. Hence, in the most dramatic parts of the defense program, price indexes do not appear as explicit variables in the framing of problems.

But specific actions are not taken *in vacuo.* We know, for example, that price movements started in one sector have a tendency to spread either because of their effects on costs and competitive products, or because of the rôle of price indexes in escalator clauses in wage and other contracts, or because of their tendency to act as sympathetic vibrators. Price indexes provide clues as to whether, because provision has been made for flexibility, that provision for flexibility has been abused.

While the precise relation in which price indexes stand to many of the practical problems faced in the defense program is tenuous and difficult of exposition, yet nevertheless price indexes are indispensable equip-


INDUSTRIAL PRODUCTION AND WHOLESALE PRICES
1935-39=100
WHOLESALE PRICES
INDUSTRIAL PRODUCTION*
INDEX
1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942
0 20 40 60 80 100 120 140 160 180 200 220

ment to the proper conduct of such a program, particularly when it encompasses civil needs as well as the production of armaments.

That general purpose indexes are used as working tools and do have an important bearing on decisions is indicated by the chart of wholesale prices and industrial production which has been one of Commissioner Henderson's constant desk companions for some time. The striking feature of the chart is the stability of the price level for the recent period while production was rising sharply to new high levels. Of course, we in the Defense Commission like to think that our activities were in some way responsible for the stability of the price level while production was expanding sharply.

Further indications of the importance of price indexes are to be found in the recent work both in the development of special purpose indexes and in the extension of general indexes done by the Bureau of Labor Statistics at the request of the Defense Commission.

For the purpose of keeping a closer check upon retail markets than was previously possible, retail price and cost of living indexes of the Bureau of Labor Statistics have been placed upon a monthly rather than a quarterly basis. In addition, for the purpose of following local repercussions of defense contracts, arrangements have been made for the collection of price data in smaller towns not previously covered, particularly those directly affected by defense orders.

Prior to the establishment of the Defense Commission, but in response to the situation created by the outbreak of war in Europe, a daily index of the spot prices of 28 basic commodities was constructed by the Bureau of Labor Statistics. This index enables a close watch to be kept of the course of those prices which tend to set the pace and act as levers in the whole price structure.

Directly related to the procurement and planning aspects of the defense program are the indexes of 14 strategic materials and of 15 critical materials—the former being materials for which we depend in whole or in substantial part upon sources outside the continental United States, and the latter being materials not quite so essential or which are obtainable in more adequate quantities from domestic sources.

Now in process of preparation are indexes of the price of waste materials, of import commodities, of export commodities, and of machine tools. The waste material index is important because such materials are alternatives for virgin materials and tend to be sensitive barometers of changing market forces. The export and import commodities indexes are for the purpose of measuring the effect of world conditions upon our price structure, while the machine tool index is for the purpose of meas-

uring price changes in an area subject to extreme pressure upon capacities under the defense program.

Also, in process of preparation are indexes of prices of individual building materials on a delivered basis by geographic regions to meet the need of measuring the impact of defense construction in local areas and to aid in the planning of construction activities.

With all these newer indexes added to those previously available, we feel that, for the time being we have a pretty good set of indexes and of price material generally for following price trends and price levels. How well prepared we are may best be seen by taking a look back some 25 years to the last time national defense became an acute problem.

In 1915, the Bureau of Labor Statistics had just started to publish a wholesale price index on a monthly basis; about 250 commodities were covered and weights were rough. Contrast this with the current work of that Bureau. Today data for about 5,000 commodities are compiled and for a majority of these, compilation is on a weekly basis. Nearly 900 of the series are used in the computation of an all-commodities index of wholesale prices; and that index as well as indexes for 10 major commodity groups are published weekly.

In the field of retail prices and the cost of living the contrast is even sharper. In 1914, the Bureau of Labor Statistics collected prices for 23 foods in 41 cities each month and price data for coal in most of those cities. Today, we have indexes of the cost of living and of retail prices for some groups of items prepared by the Bureau of Labor Statistics, not to mention those prepared by private agencies.

In fact today, the Bureau of Labor Statistics alone has more price material readily available for use than all the price index factories in existence in 1914. This time we don't have to start almost from scratch as we had to do in the 1917–18 period. And no matter how much of a strain is placed upon the economy during the next few years, one may feel confident that it will not be necessary to adopt priorities for the consumers of the price index industry.

Such further work on price indexes as may be initiated under the defense program will most likely be along the lines of special purpose indexes. Examples of the path this development may take are: indexes designed to be of use in procurement activities for selecting commodity specifications or for the carrying on of contract negotiations; and indexes designed to measure the terms of trade between our country and the Latin American countries.

The problem of measuring price balance is one on which further work needs to be done. Balance in the price structure may be gleaned from

extensive comparisons between various indexes such as those frequently drawn between raw material and finished goods prices, between farm and industrial prices, between capital goods and consumers goods prices, and so on. The index of wholesale price dispersion constructed by Walter Keim of the Bureau of Labor Statistics is one of the most useful contributions so far made in this direction. His original work was done while on the staff of the Work Projects Administration and has been published by that agency. There ought to be more such contributions as Mr. Keim has made.

The availability of price and other data during recent months has been a tremendous asset on the side of orderly and vigorous development of economic activities. Those who during the years have labored long on the theory of price indexes, on the extension and improvement of the basic observations, and on the computing may justly take pride in the state of preparedness of their price index industry. To them must go part of the credit for the smoothness with which the defense program has gotten under way. And it is with the help of the data they have developed that we hope to avoid the evils of the World War period.

What was bad during the World War period was not so much the wild price movements *per se* but rather something deeper. Among the tenets upon which our economic organization is based is that income is a reward for services rendered and that the amount of income should be in some way coordinate with the services rendered. It was in the violation of these tenets that the evils of the World War period lay.

The most visible technique used for the violation of those tenets was, of course, the rapid spiraling of prices. But we know now that behind the price scenes there were many other elements at work from disorganization in the procurement activities to market manipulation, which not only made possible the price disturbances but also hampered the effort of the World War period. And it is by treating the factors behind prices that we hope not only to avoid the evils of the World War period but also to build a better and stronger economy for all.

AN APPRAISAL OF INDEX NUMBERS OF PRICES FARMERS PAY*

By Joel Dean and Mary Hilton Wise
The University of Chicago

THE UNITED STATES Department of Agriculture Index of Prices Farmers Pay serves as an administrative aid to the Purchasing Power Parity program by indicating the changing value of the farmer's dollar in buying non-farm products. This special use of the index may involve restrictions on the type of index which may be constructed, its formula, the base period, commodities excluded, etc. In this paper, however, the Index of Prices Farmers Pay will be appraised by economic and statistical rather than administrative criteria.

The U.S.D.A. index contains two main series, prices farmers pay for commodities used in production, and prices farmers pay for commodities used in family maintenance. These series will for convenience be referred to as the cost of production and the cost of living indexes, respectively, although the index for consumption goods does not include articles produced on the farm and excludes most services, while the index for production goods also omits some items which contribute to farming costs.

The formula used for computing the index is the fixed weight aggregative type, with a pre-war base period, 1910–14. The weights for the cost of production index are those for the period 1924–29, while the cost of living index weights relate to the year 1936. In combining the two into a single series, the relative weights were determined by adjusting the value of commodities for farm family living in 1936 for the fall in the price level between 1924–29 and 1936.

The use of a fixed weight formula raises difficulties in the interpretation of the index. Recent developments in index number theory indicate that formulae involving both base and given year weights for cost of living indexes are superior to fixed weight indexes. In terms of basic utility theory it has been possible to define the true cost of living index as the ratio of the monetary expenditures of an individual which secure for him the same total utility or standard of living in two situations which differ only with respect to prices.[1] Similarly, a cost of production

* Revision of a paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940. We are obliged to Dr. O. C. Stine of the Bureau of Agricultural Economics and to Dr. Roger Hale of the Agricultural Marketing Service for critical review of this manuscript. We have profited from their criticisms, although we have been unable to accept all their suggestions.

[1] The controversy that has centered around the choice of an index number formula seems to have arisen largely because of imprecise definition of what was to be measured. Changes in "purchasing-

index is the ratio of expenditures in two different price regimes which enable the producer to maintain the same output if the production function, and all other things remain constant. On the basis of certain reasonable assumptions it has been shown by Wald that a close approximation to the true index of changes in the cost of living can be obtained by the use of Fisher's "ideal" formula.[2]

Unfortunately, the application of the "ideal" formula requires budgetary sampling for each price situation represented in the index series, in order to determine given year weights. The difficulty of such an undertaking is perhaps sufficiently indicated by the time required for the Consumer Purchases Study, begun in 1936 and only recently completed. Index numbers requiring comprehensive quantity sampling for each period under consideration are perhaps infeasible at the present time, unless continuous small samples could be taken.

Several compromises might be attempted, however. If weights cannot be determined every year, they might be determined every five years; in computing an index number, base year weights could then be combined with weights determined for the period nearest the year in question. This seems to represent a superior solution to a periodic shifting of the weights, which is the practice of the Bureau of Labor Statistics, although periodic shifting is to be preferred to a fixed weight series.

If it becomes administratively feasible to shift the price base to a recent period, comparisons of present prices with very early prices will not be made any more inaccurate, while comparisons between recent years will be improved.[3]

In attempting to choose a formula which will give the index a clear meaning, it must be emphasized that the following simplifying conditions are assumed in developing suitable formulae for an unequivocal

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power," "the value of money," or "pure price change" do not convey an exact meaning until they have been related to basic utility theory. The reader is referred to the following articles in the *Review of Economic Studies:* H. Staehle, "A General Method for the Comparison of Price of Living," Vol. IV, June 1937; A. P. Lerner, "A Note on the Theory of Price Index Numbers;" and R. G. D. Allen, "Some Observations on the Theory and Practice of Price Index Numbers," both in Vol. III, October 1936. The following important articles appeared in *Econometrica*, Vol. VII, January 1939; H. Schultz, "A Misunderstanding in Index Number Theory: The True Konüs Condition;" and A. A. Konüs, "The Problem of the True Index of Cost of Living."

[2] A. Wald, "A New Formula for the Index of Cost of Living," *Econometrica*, Vol. VII, October 1939. See also R. Frisch in the same journal, Vol. IV, January 1936. For similar work on production index numbers see an unpublished paper by H. G. Lewis and L. Court, "Production Cost Indices."

[3] The Central Statistical Board has recommended the average of the period, 1935–39, as a suitable base period for all government indexes. Dr. Hale has pointed out to us that the period 1935–39 cannot be considered a "normal" one if we take the average relation which has existed over a past period between prices received and prices paid by farmers as a criterion of normality. Prices received by farmers have averaged 88 per cent of prices paid for commodities over the past 30 years, as compared with only 82 per cent in the period 1935–39, according to a comparison of these indexes on a 1910–14 base. It is doubtful, however, whether an average of relative prices over past periods can be interpreted as a normative equilibrium position to which the economic system should or will return.

comparison of the cost of living or the cost of production in two different periods: (1) that the basic pattern of consumers' tastes (or producers' technology and anticipations) remains unchanged; (2) that the same selection of commodities is available in the two situations; (3) that the group of consumers or producers for whom the index is being prepared is homogeneous with regard to tastes and circumstances. In other words, a good approximation to the true cost of living index is only *assured by any formula when substitution among goods results* only from changes in prices.[4]

Obviously, any assumptions about the constancy of consumers' tastes or of technical methods are unjustified in considering index number comparisons over the last 30 years. The introduction of automotive equipment alone has revolutionized farming methods, and many new commodities have made their appearance in the consumer's budget. But doubt about the accuracy of index numbers using both base and given year weights only reinforces the suspicion that no valid economic interpretation can be attached to an index employing the same weights over a period of 30 years.[5]

The question of changing weights cannot, of course, be separated from that of changing tastes, quality, technology and product availability. Farming methods have undoubtedly undergone great changes since 1910. Old line types of farm equipment have been notably improved in efficiency and durability, while the introduction of both mobile and stationary power units has modified both the methods and scale of farming. An example of greatly improved equipment is to be noted in the case of rubber tires. The tire cost per mile of automobile travel today, as estimated by the Department of Agriculture, is only 25 per cent of what it was 25 years ago, as a result of an increase of 700 per cent in estimated miles of service per tire.

Although engineering estimates of increases in efficiency do not measure economic gain, there are many classes of commodities in which an increase in durability or performance will have a similar significance to a fall in price. An increase in the mileage life of rubber tires of 5 per cent is as acceptable to most people as a fall in price of 5 per cent. Prices per car mile of tires might, therefore, be a less misleading component in an index than unadjusted tire prices.

The substitution of prices of technically defined equivalents (i.e. tractor acres instead of tractors) for prices of conventionally defined com-

[4] Although these ideal conditions are never completely fulfilled we should seek to approximate them and should recognize that departures from these conditions result in errors additional to formula biases.

[5] If it is necessary, for statutory reasons, to compare 1940 with 1910–14 (although such a comparison can at best mean little) weights as nearly typical of 1940 as possible should be crossed, probably by the "ideal" formula, with the best weights that can be determined for the base period.

moditics would require care.[6] However, for certain types of producers' goods, whose services are highly specialized, statement of prices in terms of technically defined service units would undoubtedly increase the economic significance of the series.[7] Although the use of technical criteria in the definition of commodities always involves some measure of economic irrelevance, in many instances the consequent distortion of the index will be much less than that resulting from the use of ordinary commercial units. Since the definitions of commodities which alter rapidly in economic characteristics are merely conventional, recognition should be given to the fact that indexes that include such commodities are not comparable over any considerable period of time. Frequent revisions of the weights, while not making dissimilar periods comparable, will serve to make the indexes more representative for each period and will make the direction of change of the index at any point in time more significant.

INTRODUCTION OF COMMODITIES

In a fixed weight index, the changing importance of various commodities is only indicated in an indirect and possibly perverse fashion by whatever changes in prices result from shifts in demand. This weakness, which lies concealed for the most part, is brought into the open when a shift in demand is so great that a commodity must be added or dropped from the index. The question as to when, and at what level to introduce a new commodity into a fixed weight index must be answered in a somewhat arbitrary fashion, although the point at which commodities are introduced will have an important effect on the level and even the trend of the index.

When adding a new commodity to a group, the practice of the U.S.D.A. is to make the index of the new commodity equal to that of the group of commodities to which it is added, regardless of the price history of the new commodity. The criteria for introducing a new commodity seem to be two: (1) its price must have become fairly "stable" at the time of its introduction, and (2) the commodity must represent a significant portion of the farmers' expenditure. Since rapid changes in

[6] It is assumed that hedonistic equivalents for consumers' goods cannot at present be calculated accurately. However, see Andrew Court's article "Hedonistic Price Indexes," in the *Dynamics of Automobile Demand*, General Motors Corporation, N. Y., 1939.

[7] There are many difficulties in formulating economic equivalents objectively, among which may be mentioned:

(1) Technical equivalence on the basis of comparative average cost per unit will be altered by changes in relative prices of inputs.

(2) Producers are differently affected by the various aspects of technical advance (e.g. speed, durability, capacity, etc.).

(3) Estimates of average cost may prove erroneous if the equipment is outmoded before it wears out.

Notwithstanding these difficulties, the use of technically defined commodities would in many cases clarify the economic significance of the index.

prices of goods purchased by farmers are likely to be downward as the result of improvements in the technique of manufacturing new articles, the exclusion of fluctuating prices probably gives the index an upward bias. Such a bias may result in understatement of the relative well-being of the farmer, since a new article in attaining an important place in the consumer's budget displaces products of less utility per dollar of expenditure.[8]

No entirely satisfactory solution to the problems involved in introducing new commodities is possible. While no commodity should be omitted which represents a sizable proportion of consumer expenditure, consideration should be taken both of the price history of the new commodity and the commodities it displaces in determining the level at which it should enter the index. Refusal to introduce commodities until their prices have become stable may result in serious misrepresentation of the effects of the revolution in techniques which have cheapened consumers' goods and made farming methods more productive.[9]

The effect of the introduction of new commodities at a more or less arbitrary level is strikingly illustrated in the case of motor vehicles. Expenditures for tractors, automobiles, and motor trucks, as nearly as can be determined from available data collected by the U.S.D.A. amounted to about 69 million dollars, or about 1.2 per cent of total farm income in 1910. From 1910 to 1914 such purchases averaged about 25 per cent of farmers' purchases of all types of machinery. Yet motor vehicles and automotive machinery were not introduced into the index until 1917, when expenditures for these articles amounted to 55 per cent of all farm machinery and about 4 per cent of farm income.[10]

The U.S.D.A. indexes for tractors, for automobiles, and for automotive supplies were compared with indexes for the same groups computed on an actual 1910–14 base, using the same weights as the U.S.D.A. index employs and price data supplied by the U.S.D.A. it-

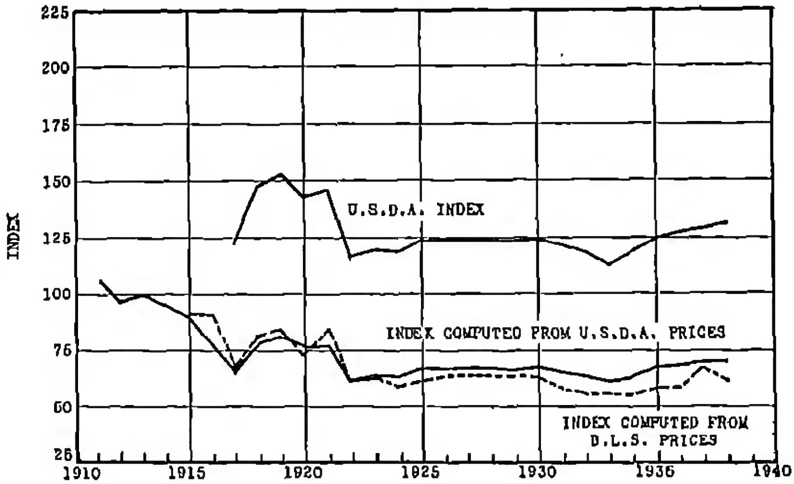
[8] For example, rayon, preferred to cotton for many uses, and constituting a cheap substitute for silk, has raised consumption standards of most income groups. Yet rayon fabric was introduced into the U.S.D.A. index in 1930 at a level of 140 (since this was the index of its group—clothing, in that year). The introduction of rayon into the index in this manner, therefore, fails to reflect any gain to the consumer.

[9] For example, electric rates are not yet incorporated into the index although the U.S.D.A. states that by the end of 1930, 15 per cent of farms in the United States were receiving electric current. In some regions the proportion was over 60 per cent. In the case of electric power for farm production, the U.S.D.A. considers that the electric power rate may not be sufficiently stabilized to warrant introducing power rates into its index. See *Income Parity for Agriculture*, Part III, Section 2, "Rates for Electricity for Farm Home and Farm Power."

[10] See Table I, Part II, Section 3 of *Income Parity for Agriculture*. When introduced, that portion of automobile purchases allocated to productive activities was assigned an index of 122—the 1917 level of old-line farm machinery. Similarly, that portion of automobile purchases allocated to farm living was introduced at 120, because the price of a group of commodities designated as household supplies was at that time 120 per cent of pre-war. This group consisted of brooms, soft coal, hard coal, kerosene, laundry and toilet soap, laundry starch and wood.

self in the recent preliminary reports of the series *Income Parity for Agriculture.* The chart shows the results for tractors. The series for automobiles and automotive supplies exhibits highly similar behavior.

COMPARISON OF INDEXES OF PRICES PAID BY FARMERS FOR TRACTORS
U. S. Department of Agriculture Indexes, 1910–14 = 100
Bureau of Labor Statistics Wholesale Price Index, 1913 = 100



The disparity between the U.S.D.A. series and the ratios of actual prices does not necessarily lead to the conclusion that automobiles, supplies, and automotive equipment should have been introduced at the actual ratio of their prices to their 1910–14 prices. Neither does it show that the Department should have introduced the series in 1910, since with their present weights the group would probably have exaggerated the farmers' benefit from declining tractor prices. Nevertheless, the graph does indicate the degree of arbitrariness involved in the use of fixed weights which cannot be representative of widely divergent periods.

NON-HOMOGENEITY OF GROUPS SAMPLED

The United States is characterized not only by wide regional disparities in the level of income, but also by wide regional variability in the consumption patterns of similar income groups, particularly in rural sections. Since price changes will affect various groups differently, index series should be computed for each major classification of population according to living standard. Regional indexes should be given wide circulation in order to avoid misleading indications of changes in relative well-being for various sections.

The same considerations seem to apply with even greater force to *farm production indexes, both because of regional differences in major* crops, and because modern and antiquated methods of farming persist side by side.[11]

Because of the diversity of consumption patterns and farming techniques, separate indexes by regions and farm-types are urgently needed. Fortunately, it is easier to obtain homogeneous geographical samples than to secure successive samples that are comparable over a period of years.[12]

COMPARISON OF OLD AND NEW SERIES

The index numbers of Prices Farmers Pay were considerably revised in 1939. Both the old and the new series include the same subseries with the exception of the addition of livestock to the production index. Nevertheless, a number of new commodity components of the subseries have been added and there has been some regrouping. Although the direction of movement of the old and revised indexes is highly correlated, the discrepancy between the two series amounts to as much as eight or ten points over much of the range since 1923 and the new index lies below the old from 1921 onward.

The disparity between the new and revised series cannot be considered negligible. It results from (1) corrections of price series, (2) improvement of weights, (3) possible shifts in expenditure patterns between 1929 and 1936 (in the case of the cost of living index).

Even though the weights for the production index are for the same *period in both the old and new series, however, it has been found necessary* to modify them substantially.[13] If the sampling for cost of living indexes was qualitatively comparable with cost of production sampling in the old series, modification of weights in the cost of living index are more likely to represent corrections for previous sampling deficiencies than to indicate change of habits of expenditure.[14]

The Consumer Purchases Study, from which the present weights for the family maintenance index were taken, appears to have been as

[11] In the 1930 Census, over 90 per cent of farms were reported owning automobiles in Iowa and Nebraska, as compared with less than 50 per cent in the South as a whole and only 25 to 30 per cent in some southern states. Such figures indicate that the non-homogeneity of the universe sampled for the index *at any point in time may exceed the non-homogeneity of successive samplings through time,* although the latter source of trouble has been much more emphasized.

[12] A few state index numbers are being constructed, but usually with the same formula and weights as the U.S.D.A. national index.

[13] *Some reduction in the weights of all former groups was necessary to allow for the inclusion of the* new series, livestock, which was given a weight of 12 on the basis of 100; it thus appears more important than any of the 9 component series with the exception of feed. The omission of livestock from the original series, is, therefore, very difficult to understand. Building materials were assigned a weight of 10 in the new series, as compared with 16 in the old. Changes in other groups of two or three points have been made.

[14] For instance, clothing was reduced from 30.4 to 22.0. Food was advanced about 2 points and building materials were reduced in importance, while automobiles advanced from 6.3 to about 10. A severe drop in the relative importance of food might accompany sharply rising incomes, but otherwise changes of such magnitude seem to indicate sampling deficiencies either in the past series or the present series, or both.

extensive as is feasible, and to have been carefully planned. We are led to hope, therefore, that the farm budget drawn from this study presents an accurate composite picture. If future changes in weights are based upon studies of comparable accuracy, they may be accepted as showing predominantly the change in consumer spending habits.

COVERAGE AND PRICE SAMPLING

The prices of services, which account for between one-sixth and one-fifth of the farmer's living budget, are not included in the cost of living index. This deficiency has been partly remedied by the compilation of special index numbers for services and also for commodities not included in the main series. These data are available for the periods 1910–14, 1924–29, 1932 and 1936, and may be combined with the general index for these scattered periods when desired. Of more importance, perhaps, is the lack of a series of prices for commodities raised and consumed on the farm.[15]

For the production budget, separate series have been developed for prices paid to hired farm labor, and for taxes and interest. These are frequently incorporated into the index of production when it is desired to compare the latter with the index of prices received by farmers.

The price data used in the index represent cash transactions at local independent stores. While independent stores supply farmers with a high percentage of some articles of consumption it seems undesirable to confine the price sample to these outlets.[16]

In 1939, about 20,000 independent merchants submitted price data to the U.S.D.A. on the items included in the index.[17] More quotations per item are collected on food prices than for any others, although over

[15] It is estimated by the U.S.D.A. that in 1941 farm produced commodities will be, on the average, over half as important in the family maintenance budget, as commodities purchased in the market. This fact appears significant when we consider the wide regional differences in the proportion of farm production consumed on the farm and the probability that farm families divert more resources into family maintenance when market prices are low.

[16] A survey by the U.S.D.A. in 1935 indicates that mail-order houses supply about a quarter of farm clothing, one-fifth of household supplies and furniture, and smaller proportions of other articles. Chain stores are credited by the survey with one-fourth of food purchases, one-sixth of clothing purchases, and smaller amounts of other articles. The U.S.D.A. emphasizes the need for including quotations from chain stores and mail-order houses, since both the level and trend of prices in these types of retail outlets may differ from those of the independent stores. Data are being assembled on prices charged by chain stores and mail order houses, which presumably will be incorporated into the index numbers in the future.

[17] One of the knottier problems encountered in securing price quotations was that of prescribing specifications for the commodities included, since for many commodities there are no recognized standards. According to A. R. Sabin, of the Agricultural Marketing Service, broad specifications for commodities have proved to be the best approach to the problem. "Narrowing of specifications restricts the coverage of the field and reduces the representativeness of estimates based on such specifications." ("Prices Paid by Farmers, an Appraisal," the *Agricultural Situation*, September 1939, p. 10.) For some commodities, therefore, the respondent is told simply to quote the price for the type that farmers most frequently buy. The resulting variability in commodities sampled is likely to be of little significance, however, unless there is a systematic tendency for lower quality articles to be purchased during depression years, or unless the modal quality bracket is tending upward.

5,000 towns report clothing prices and over 3,000 furniture and furnishings.[16]

Accurate price sampling is particularly difficult for certain types of commodities, as is illustrated by rather pronounced differences between price series as reported by the Agricultural Marketing Service (which are used for the Department of Agriculture indexes) and the Bureau of Labor Statistics. Even though the base periods are approximately the same, the dispersion between the automobile and automotive supplies series based on the published prices of the A.M.S. and those based on the B.L.S. wholesale price index seems to be greater, especially in recent years, than is explained by the fact that one is a series of retail, and the other a series of wholesale prices.[17]

In conclusion, certain suggestions may be summarized. In view of the desirability of using Fisher's "ideal" formula for computing the index, the possibility of obtaining new weights each year by means of permanent, small stratified samples merits consideration. On the basis of the extensive Consumer Purchases Study, it might be possible to select a small number of families typical of each major region, farming type, and income group and to have these families keep records of their expenditures. The more homogeneous the sub-groups the smaller may be the number of families sampled. Construction of subsidiary cost of living and cost of production indexes for various regions and types of farming seems desirable, even if the weights must be based on very small samples.

Failing this, revision of the weights every few years seems desirable. The base period should probably be shifted to a more recent period, possibly 1935–39, if this becomes permissible under the revised statutes. Introduction of new commodities as soon as they assume importance in the budget regardless of whether their prices are stable is recommended. Although no satisfactory theoretical solution exists for the problem of the price at which the new commodity should be introduced, it would seem logical to have regard both for its price behavior while it was growing in importance and for the price of the commodities it supplements. Expression of prices of certain commodities in terms of units of service (e.g. tire miles and truck ton miles) rather than in terms of conventional units appears to merit further consideration.

[16] Although the towns returning food price quotations are of all sizes, there are a large number between 5,000 and 50,000 and 82 towns over 50,000 in population. To the layman this would appear a rather high coverage of the larger centers of distribution; nevertheless, studies of farm buying habits may have shown that this rather intensive sampling of large towns is justified.

[17] Automobiles on the basis of A.M.S. series (1910–14=100), stands at 87. The B.L.S. wholesale price series for automobiles using the same weights (1913=100) is only 67.2. The A.M.S. price series gives an index for tires of 60.6 while the B.L.S. stands at 28 in the same year. For gasoline, the price series of the A.M.S. gives an index of 97.4 for use in automobiles and 99.9 for tractors, as compared to the B.L.S. index of 67.2 in 1938.

PRINCIPLES AND PROCEDURES FOR PUTTING ACROSS BUSINESS STATISTICS REPORTS TO EXECUTIVES*

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In its broadest interpretation our present problem is how to present the results of research effort to the executive. Let us first narrow the statement of the problem.

1. This paper is not concerned with ways and means of putting across commercially published statistical reports.

2. No consideration is given to problems incident to presenting weekly, monthly, quarterly, or on any other time basis an intricate system of chart control for the chief executives of a corporation to follow and by which to direct the activities of their organization.

3. No consideration will be given to the problems incident to presenting all manner of business statistics to all manner of business executives.

There may be other sub-classifications of this broad topic which should be eliminated, as this discussion is limited to the principles and practices of presenting specific problem analyses to the executives of a particular corporation, no matter what its corporate title may be.

Statistics and statistical methodology are limited to data available and to various manipulations that the trained research man will adopt in attempting to reach sound generalizations based upon a multiple number of observations so that a solution of some definite confusion or uncertainty may be presented to management. Statistical analyses are not ends in themselves but are a means whereby the trained analyst seeks to find a clear-cut path through the fog of uncertainty.

The Receivers. Business executives make decisions about the best course of action at particular times when confronted with particular problems. They are eager for help in finding the solution of many of the problems which must be encountered daily. Their objective is to eliminate the pure chance element and reduce uncertainty to a minimum.

The very existence of a commercial research department on a corporation payroll is vivid testimony that the executives of that corporation desire whatever assistance research men may be able to give to management in selecting proper courses of action at the right time. There is an obvious desire for the results of statistical and economic analysis. The audience, therefore, is receptive regarding the results of analyses of problems.

* A paper presented at the 102nd Ann[illegible] of the American Statistical Association, Chicago, December 28, 1940.

The Transmitters. The other side of this human equation is represented by the members of the commercial research department. What is essential from their point of view in this process of thought transmission?

The objective of the research man is to marshal factual evidence pertaining to the various problems of management, formulate major conclusions thereon, and recommend that course of action which appears best in the interests of the public, employees, and stockholders. He is obligated to acquaint himself sufficiently with the various parts of the industry in which he is working to be able to draw true inferences from the data with which he is working. He must be strictly honest in his presentation of factual evidence and possessed of a thorough understanding of sound sales procedure. He must be impervious to flattery and possessed of the courage of his own convictions. It is sometimes necessary that he stand absolutely alone on specific policies. He should maintain close contact with the sales department, know its promotional activities, and its operating policies.

Many problems assigned by management to a research department are of an urgent nature by the time they are called to the attention of the research analyst. Speed is the essence of many actions which must be taken in the business world. It is essential, therefore, that the good research man be able to select the more promising approaches to the solution of the problem and follow these particular avenues of approach first before resorting to less promising alternate approaches to the solution of the problem. This frequently requires a careful balancing in the mind of the analyst of the importance of time and the ultimate in accuracy. The leisure and thoroughness of academic research are seldom available to the commercial analyst as it is frequently necessary that the output of a department be the result of long hours of grinding, often under considerable pressure to meet deadline dates.

The successful research man must likewise be a good salesman. The analyst should be able to organize his thinking in logical sequence so that the presentation of evidence will lead to an easy and ready acceptance of his conclusions by the executive audience. Likewise, it is a material asset if the research man is capable of speaking directly and forcefully in support of his analyses and findings.

Where these essential requirements are deficient in any of the members of a department, extremely careful supervision and checking of results are necessary. To find individuals possessed of these characteristics is a major problem confronting any director of research activities to a far greater extent than is the problem of getting the results of his analysis before the executive audience.

The Exchange of Information. The essential characteristics of the two parties to the exchange of information have been briefly outlined and the problem limited to the exchange of a particular type of information between these two groups. What is the best way of exchanging this information? This varies widely according to the functional set-up of different organizations.

In an organization where research is (1) directly responsible to the chief executive, (2) free from departmental influences, (3) given absolute freedom of the press so that any finding or recommendation may be presented to the chief executive of the corporation, and (4) given opportunity for frank discussion and interchange of ideas by the research department and management, it is my belief that the written report form offers one of the best solutions.

Under these ideal conditions the first step in the procedure is usually a frank discussion between management and the research representative as to the exact nature of the problem to be analyzed. Do not anticipate securing in this manner a complete and detailed outline of the problem to be solved, as frequently the assignment will represent some confusion on the part of management, but certainly our efforts can be directed more intelligently if we know what these difficulties really are. At times the assignment may be extremely broad and very general because the exact nature of the problem may not be apparent to either management or the research man until a sufficient amount of exploratory work has been done to evaluate more thoroughly the true dimensions of the study to be conducted.

Having secured as clear an outline of the problem as it is possible to get from a discussion with management, exploratory work is undertaken. As results of this materialize, careful notation should be taken and notations converted into a complete written analysis to the management. Such a report becomes at one time a reflection of the problem to be analyzed, a reflection of the audience that is to receive the results of the analysis, and still a reflection of the analyst conducting the study.

Certainly a report having to do with an analysis of various expense items would differ markedly from a public attitude study or from the type of analysis incident to the introduction of a new product. Mechanically they may be similar but actually there would be a wide difference in the presentation thereof so that clarity of thought transmission would be possible.

A report likewise is a reflection of the audience to which it is directed. Do not underestimate the significance of this particular feature in drafting your presentations. The writer should be thoroughly conversant with the members of his audience, know their interests, their prob-

lems, and their particular way of acquiring, absorbing, and applying information relative to the various analyses conducted.

The report is naturally a reflection of its author as it is a concise picture of his manner of thinking, working, and arriving at conclusions in the conduct of a business. Under these conditions the report in its written form will achieve the following results.

State the Problem Clearly. Frequently this is one of the most difficult parts of report writing—knowing exactly the limitations of the subject matter meriting particular attention on the part of management and justifying consideration for inclusion as part of the analysis. Often a careful weighing of comparative significance of different phases of the problem is necessary so that the report in its written form may possess the desired conciseness, simplicity, and directness which are essential to good reception.

Outline Briefly the Approach to the Solution of the Problem. This is of primary importance when the analysis under consideration is of a non-recurring nature. Many departments have a certain number of reports which recur annually and in which the writer can advantageously brief or omit any detailed description of the procedure to be followed in the analysis of the problem.

Present the Evidence. All significant evidence bearing on the problem under consideration should be presented step by step in the logical sequence of the evolution of the solution of the problem. There is no mechanical means of outlining a procedure for best presentation of evidence on all problems to all groups of business executives. The form of presentation must be an adaptation which is based on the interests of the audience. For some particular audiences charts may be a handicap rather than an assistance. Probably it would be safe to say that for most business executives charts should be used only when a well organized table of carefully arranged data would not present the idea equally well. When charts are used, keep them simple. Too many thoughts consolidated on one chart requiring long and tedious study will seldom receive the attention that the author would desire. Frequently use of logarithmic paper does not result in the true interpretation of the points it is desirable to bring out. Pie charts are seldom easy of correct interpretation of relative values, for the eye is slow to draw correct conclusions for evaluating comparative significance of tractors, horses, or other objects drawn to different scales to represent comparative values.

As evidence is presented on any one segment of the problem, draw conclusions and recommendations thereon directly associated with the factual evidence. Upon completion of the report, all important conclusions and recommendations should be recapitulated in the first few

pages of the analysis. Avoid criticism of individual departments or individual members of a department, making recommendations based purely on factual evidence impersonally presented.

Draw True Inferences and Deductions from Evidence Presented. It is at this stage of the report that the research analyst must exercise the greatest care in his thinking processes to insure that his thinking is entirely practical in view of all ramifications of the problem at hand. It must be completely fearless in presentation of true inferences from facts previously presented. It is important that the significance of the various deductions be interpreted and applied to the business of the particular corporation and, in addition, that the full significance in terms of profit, sales policies and procedures, and competitive advantages resulting therefrom be pointed out.

Frequently such deductions may lead to a changed course of action as compared with policies which have been in existence for a considerable period of time. Under these conditions it is well to anticipate objections which may arise from the new proposed course of action and meet them directly in the presentation. Pre-selling of such ideas by personal contact with any persons influenced by the change is often beneficial in securing cooperation in the desired course of action. This pre-selling may take the form of mentioning to executives concerned some of the principal findings prior to submitting the actual report.

The research ideal should not be surrendered in such discussions but frequently the research man's understanding of the complete problem will be beneficially influenced by such procedure, and even if no such benefit is derived therefrom, it is the sporting thing for the research man to do, so that the executive affected may have a fair time and opportunity for presenting his case in justification of any policy previously formulated. Where clashes of opinion are inevitable, the research evidence must be presented in a positive manner if it is to overcome the natural inertia to change of long accepted procedure.

Recommend Courses of Action To Be Taken by Management in Its Choice Determination Function. All recommendations included in the report incident to the presentation of evidence and inferences drawn therefrom should be recapitulated in the front of the report. This provides the management with a ready summary of the principal results of the analysis for subsequent open discussion before a steering committee. The report in its completed form should be brief, direct to the point, concise, neatly prepared, and easy to read. Its set-up from beginning to end should provide the best sales approach to the important task of influencing the selection of the proper course of action to be adopted. It should then be submitted to all members of an appointed steering

committee, of which the chief executive or the executive vice-president serves as chairman.

The members of the committee should have the opportunity to read, study, analyze the contents of the report and submit rebuttals to all members of the committee where desired. After each member has had an opportunity to analyze the contents of the report, a meeting should be called for a frank discussion of the problem and recommended courses of action proposed by the research department. Each recommendation should be treated separately and completely, and either accepted as a modification of existing policy or rejected. In any such discussion it is essential that recommendations be discussed impersonally, impartially, and with an even temper by all parties concerned. The research man should be able to discuss the various phases of the study and the application of courses of action recommended.

The receptivity of the research reports is frequently enhanced with the passing of time, enabling the business executives to increase their contact with the findings of the department. If the department builds up a reputation of practicality, resourcefulness, and impartial judgment, it is a reasonable expectancy that impartial hearing and eagerness for any recommendations and conclusions may be anticipated.

Throughout this brief discussion I have probably placed greater emphasis upon the sales aspect of the research man's duty than is commonly encountered. What is more important, if commercial research is to contribute its maximum to sound management, than that the individual who has collected, assimilated, analyzed, pored over the data relative to any given problem, should first state clearly what appears to that individual as the best course of action to pursue, depending primarily upon his evidence to substantiate his opinion, and then sell the results of that work to the best of his ability?

There must be a cooperative spirit between commercial research men and management if a research department is to justify its existence. The interests of the executives and the analysts are identical as they both seek the best course of action to take when confronted with particularly confusing conditions.

Where, then, is the real problem of presenting statistical findings to business executives? The real problem is to find men meeting the qualifications of the research man above enumerated, who will take from the desk of management a wide range of business problems and by using the particular tools at their disposal, determine what course of action offers greatest promise, then sell the results of their analysis and thus influence choices made by business executives.

HOW THE LIBRARIAN WOULD LIKE TO FIND STATISTICS*

By Rose L. Vormelker, *Business Research Librarian*
Cleveland Public Library, Cleveland, Ohio

The librarian represents the middleman in the distribution system for statistics. The librarian ordinarily compiles no statistics except those specifically related to some phase of library work, nor is the librarian the ultimate consumer of statistics. The librarian is concerned chiefly with knowing what statistics are available and where, in order to produce them for clients of the library as requested. It is also desirable that the librarian know what statistics are not available and why in order that time not be wasted to produce something which does not exist or is not available for one reason or another, for instance, confidential figures.

There are so many misconceptions concerning the type of individual who uses the public library for information that it seems best to begin this paper with *who* requests such data.

In our Business Information Bureau (and this is probably true of any well equipped business library) requests involving statistical data are second only to the directory type of question, such as "Who are the officers of this or that corporation?" and "Where can I find out who manufacturers this or that commodity?"

These questions come from the manufacturer who wants to compare his output with that of the industry as a whole, from the industrial relations consultant who is working out a wage policy, from the labor leader trying to show trends of employment or unemployment, from the advertising agency planning a campaign, from the market analyst looking for new markets or re-arrangement of market areas, from the investor hoping to make the right decision concerning his dollars, from attorneys needing statistics for legal evidence, from trade papers to learn the extent of their market, from newspaper men and public speakers to give recognized authority to their conclusions, from trade association executives for information later transmitted to their members, from Chambers of Commerce planning industrial area analyses, from economists who use statistical data to guide them in watching trends in many fields, from researchers who are researching the researchers, from students, whose instructors have assigned very specific questions to them, and others.

* Revision of a paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

Occasionally but much more rarely than is generally supposed, an obviously "crank" question is presented such as, "How far is it to heaven?" or "How many marriageable Chinese girls are there in Englewood, New Jersey?"

Many of these people call on the library before beginning any work on their problem at all. Others think of it only as the last resort after all else has failed!

Some think the librarians are magicians when they produce quick answers to what has appeared as a laborious task to them; e.g. "How many insurance salesmen are there in Chicago, Cincinnati, Cleveland and Detroit?" Others classify librarians as morons when they fail to find what seems simple to them, usually adding with conviction, "The government must have such figures." In this class came the request from a corporation attorney for figures showing the amount of taxes paid by the United States Steel Corporation for support of the public schools in Pittsburgh. He was quite sure the *census* reports on *income tax* listed the names of all corporations in the United States in one column and all the taxes they paid in another, specifying the use to which this tax money was put.

The census reports—especially those for population, manufactures, agriculture, and distribution give us so many invaluable data that it seems we should really sing a paean of praise for them. An account of the many uses to which these reports are put would fill a book. Not only are the current volumes in great demand but even the old reports are frequently used. A short time ago one of Cleveland's leading executives was called upon to speak before a national business organization on the effect of technological development on the employment of office workers. For this question the very earliest reports were used to show how the number of office workers has increased by leaps and bounds despite the introduction of labor saving machinery. Excellent papers have been prepared showing the uses to which census data are put.[1] Many of the situations mentioned in these are duplicated daily in the important business libraries of the country. To be sure, hundreds of requests, not to be classed as "crank" requests, are made for statistical data which are not in the census field. A sampling of these from recent records of our Bureau follow:

[1] Cherington, Paul T., "The Uses of the Census of Business," this JOURNAL, Vol. 35, no. 209, Part I, March 1940, pp. 107–115.

Reed, Vergil D., "Putting Business Census Facts to Work for Chambers of Commerce," an address delivered at the Buffalo Convention of the National Association of Commercial Organization Secretaries, October 25, 1937.

Truesdell, Leon E., "Value of the Population Census for Research," *Annals of the American Academy of Political and Social Science*, Vol. 188, November 1936, pp. 329–340.

How many mortgage loans were made in 1940 in Cleveland and for what amounts?
What was the industrial production index number for chemicals for the last half of 1940?
What was the amount of car loadings, weekly from the beginning of our entry into World War I to the end of 1918 and how did these figures compare with car loadings during the depression of the thirties?
How do the sales of gas refrigerators compare with those of electric refrigerators in certain specified communities?
What was the cost of living index in Cleveland and Detroit for the last ten years?
How many parts are there in an airplane?
How many man hours are required to make a bomber?
How many radio phonograph combinations were made annually by each of the larger companies in the last five years?
How many men are required behind the scenes for every man at the front?
How many corporations started in business last year and how many corporations failed?
How much coal was used in producing power in the last two years?
How many boys are in classes giving industrial training for defense?
How many women in Cleveland are available for employment in defense industries?
How many jobs now held by men could be adequately filled by women, thus releasing men for military service?
What are salaries paid, costs, and profits in the clothing industry?
What was the value of United States agricultural products exported to Great Britain, China and Greece last year?
What profits, if any, were made by producers of soy beans?
What was the price of black pepper on December 13, 1940?
What were the wage rates in the steel industry in the World War and how do they compare with present rates?
What was the high and low price of Allegheny Corporation 5's of 1940 for February 1934?
What is the prevailing factory cost of sales in the automobile industry?
What is the amount of fire loss annually?
How much lubricating oil was produced in 1940?
What was the amount of our exports of power driven metal working machinery annually, 1919 to 1940?
What was the price of automobile sheet steel at Pittsburgh in May 1928, 1929, 1933, 1937?
What was the amount of sales tax collections for Cleveland and for Ohio in 1935?

To answer these, it is essential to have the figures compiled and released by government and quasi-government agencies as: United States Department of Agriculture, United States Department of Labor, United States Bureau of Foreign and Domestic Commerce, Securities and Exchange Commission, Federal Trade Commission, Federal Power

Commission, Interstate Commerce Commission, Temporary National Economic Committee, Board of Governors of the Federal Reserve System, and others; the reports and compilations made by state, county, and municipal offices and bureaus; data compiled and published by trade papers, trade associations, or private organizations.

Some requests which have presented problems, are those for data collected by but not published by the Census Bureau. Figures which will reveal the identity of establishments because of their location are withheld from publication as most statisticians and librarians know. However one large Cleveland firm expressed considerable annoyance when the figure giving the value of a certain chemical was included in the preliminary report but grouped with miscellaneous chemicals in the final report. The reaction of professors and students in collegiate business schools to this regulation has already been discussed in a paper in this JOURNAL.[2]

Still other problems arise because figures are needed in a form other than the one in which they are found. For instance, a firm which is expanding its plant facilities for national defense production was considering a number of locations in rural communities. This firm requested cost of living figures on a county basis with special divisions for rural and urban communities with the county.

Economists, market analysts, and other workers in the field of business and statistical research have frequent need for data for their own firm's market area or for some commercial area that is very different from the political subdivision for which figures are usually collected. This has also been commented upon in previous papers.[3]

The problems arising in trying to use occupational statistics and employment statistics have also been ably presented.[4]

The questions for which data are published present no problem other than that the librarian be informed of their existence. However, as the need for figures seems to have endless possibilities and the efforts to supply them are growing by leaps and bounds, some sort of master index to statistical sources, undertaken by people adequately trained in indexing procedures, would be a great time and temper saver.

[2] McLaughlin, Glenn E., "The Inadequacy of Census Data for Individual Industries," this JOURNAL, Vol. 27, no. 177, March 1932, pp. 37-41.

[3] Papers by James N. Hobson, Alonzo B. Cox, Ralph J. Watkins, Waldo E. Grimes, Paul T. Cherington, Casimir A. Sienkiewicz, F. L. Carmichael, on "The Industrial and Commercial Area vs. the Political Area as the Unit for the Collection of Business Statistics," this JOURNAL, Vol. 29, no. 185a, March 1934. Supplement, pp. 14-23.

[4] Palmer, Gladys L., "Some Considerations Involved in Appraising the Adequacy of Occupational Statistics," this JOURNAL, Vol. 36, no. 213, pp. 61-70.

Reede, Arthur H., "Adequacy of Employment Statistics," this JOURNAL, Vol. 36, no. 213, pp. 71-80.

A start—but only a start—in this direction has been made in the *Sources of Regional and Local Current Business Statistics*, by E. S. Moulton, issued as Domestic Commerce Series No. 115 by the United States Bureau of Foreign and Domestic Commerce; *The Economist's Handbook, a Manual of Statistical Sources*, by Gerlof Renooy; *An Index to Business Indices*, by D. H. Davenport and F. V. Scott; *Selected List of Current Foreign Financial Sources*, compiled by E. S. Cavanaugh and published by the Special Libraries Association; *Price Sources*, compiled by E. M. Carmack and issued as an United States Department of Commerce publication; and "Footnotes on Time Series," on pp. 165–238 in the 1940 *Supplement to the Survey of Current Business* and comparable bibliographies in previous issues of this Supplement.

So far as I have been able to discover three attempts have been made to provide something resembling an index to census publications. These are the *Circular of Information Concerning Census Publications 1790–1916*, issued as one of a series of five circulars, "for the purpose of giving the public a better and clearer understanding of the work of the Census Bureau;" the studies made by L. F. Schmeckebier and published by The Institute for Government Research and The Brookings Institution; and the *Topical Index of Population Census Reports 1900–1930*, made up at the solicitation of the Committee on Social Statistics of the Social Science Research Council.

It is unfortunately true that the existence of even these tools is not very generally known and that the most frequent plea of librarians and others using census figures is, "If there were only an index or some explanation of what can be found in the census reports, of what is given one year and omitted in another, what a real contribution to research tools that would be!" More often than not answers to questions put to the library are wanted the "day before yesterday." For this reason we would put as a necessary "first" adequate indexing and/or detailed contents pages in one place.

When one realizes the great amount of tax money spent to gather such an invaluable storehouse of data, does it not seem just ordinarily sensible to supply it with a key that will truly unlock its contents? In hundreds of instances guesses are made concerning problems covered by census publications when facts are available which are not located because of inadequate indexing.

Librarians are not alone in voicing this need. Social workers and statisticians in numerous fields frequently have expressed the need of making available through an index not only the published but also the

unpublished data collected and on hand in the Bureau of the Census.[illegible] Recently, a man engaged in research for an advertising agency said to one of our assistants, "Funny, the Census of Manufactures gives data on piano parts but not on pianos, which happen to be what I need right now." That did seem queer! So we looked through the index again. Sure enough piano parts are listed but not pianos. At the end of the index under "Miscellaneous—Musical Instruments—Pianos," were most of the facts needed for the particular problem at hand.

If indexing must be held up a while longer there is still a way to make the data more readily available. This would be to provide an analytical table of contents. At present a number of census volumes have a main contents page which eliminates all detail and requires the user to turn to the second contents page where the tables are listed in greater detail. Is there any good reason why an analytical table of contents cannot be given when tables of contents usually are given in books? Much time would thus be saved in determining which tables give the needed figures or in proving that they are not given at all.

The next problem that has presented itself in the use of census data is the result of a re-classification of information, and omission of certain items from one report which had been included in previous reports.

A university professor on leave to do special work for the Temporary National Economic Committee, has been using Census of Manufactures figures for authentic data on comparative productivity per worker in a number of specific industries over a period of years.

Through 1937, the Census of Manufactures indicates the number of employees in the various manufacturing industries by *industry*, regardless of their particular activity in the industry. In 1939, however, for the first time, employees primarily engaged in distribution or construction activities in the manufacturing industries are reported separately.

Although we know there is increased productivity per worker due to technological developments continuously taking place, our professor's report will have more weight if his figures are on a comparative basis. No doubt the final reports will make it possible to bring these data together but until then there is this gap in the information.

Another problem relating to Census of Manufactures data occurred recently in connection with power laundries. A market analysis for a certain piece of equipment was being discussed and data on power laundries were needed. The market analyst came to us and said, "The

[illegible] Johnston, Mary, "The Need for an Index for Social Data," this JOURNAL, Vol. 24, no. 168, December 1929, pp. 398–404.

Fry, C. Luther, "Making Use of Census Data," this JOURNAL, Vol. 25, no. 170, June 1930, pp. 130–139.

Census of Manufactures is supposed to include power laundries. I've gone through this volume till I'm dizzy but cannot find it." Fortunately the Marketing Research Division of the Bureau of Foreign and Domestic Commerce in its abstract of the Power Laundries' report clarified the situation by its definite statement: "The Power Laundry is canvassed biennially in connection with the Census of Manufactures but the statistics gathered are not included in the census totals for manufacturing industries." You can see readily how useful it would have been to have had a reference to that effect printed in the volume on manufacturing industries.

Not a day passes by that some reader does not hopefully request figures in a form other than that given. For instance, "How many people in the United States live in towns of 20,000 or less in population?" and "What is the average annual wage in the public utility field in age groups 18–25, 25–30, 30–40, 40–50, and over 50?" Each of these questions concerned social and economic developments. In the first case, the client was trying to find out whether the drift of population was away from large centers and into smaller communities. In the other case, a personnel department was working on a pension plan for employees and needed some sort of barometer for determining trend of wages and salaries according to age.

This question of average annual earnings for individuals occurs frequently in various forms and the payroll data as now collected do not serve the purpose. Linda H. Morley of Industrial Relations Counselors, Inc., with whom I discussed this paper, epitomized this need in saying, "From the point of view of industrial relations the amount earned by the average individual is more significant than the amount paid out in wages."

Other questions, answers to which were very important to those who asked them, but which could not be answered from the data as now published were:

How many firms in Cleveland employ 10 to 25 people and how many employ 25 to 50 people?

How many people are employed as clerical workers by trade associations and by labor unions?

How many retail clerks are engaged in selling women's ready to wear clothing?

How much gasoline was consumed in Ohio, Pennsylvania, New York, Michigan and California, by counties?

Number of different types of heating units by census tracts for cities other than Cleveland?

How many lithographers designing labels are employed in factories making tin cans?

How many skilled and semi-skilled laborers over 40 years of age are employed by the machine tool industry?

How much capital is invested in the productive industries? (Figures are available on *capital invested* for the State of Pennsylvania from that state's Department of Internal Affairs, but to date we have not located similar data for other states.)

In conclusion, may I summarize a few needs indicated in this paper for better use of census data in libraries:

1. Adequate indexing.
2. Better tables of contents.
3. An outline of what is covered by the various census publications; e.g. Hand laundries are covered by the Census of Business while data for power laundries are collected biennially with the Census of Manufactures but these are published in a separate report; County figures may be given for some years and not for others.
4. Gathering of information on labor organizations, trade associations, social agencies and other service groups.
5. Grouping of companies by number of employees or other indication of size.
6. Adding *capital invested* for industries to Census of Manufactures.
7. Provide a breakdown of employees in Census of Manufactures according to skilled, and semi-skilled workers.

There is a much needed greater break-down for occupations, but this has already been discussed before this Association[4] and we await with great interest the 1940 report on occupations, which we have been told, will incorporate "The Convertibility List of Occupations by Major Groups," which was developed by The Committee on Occupational Classification of the Central Statistical Board and The American Statistical Association.

[4] Palmer, Gladys L., "The Convertibility List of Occupations and the Problems of Developing It," this JOURNAL, Vol. 34, No. 208, December 1939, pp. 693–708.

HOW A NEWSPAPERMAN LIKES STATISTICS PRESENTED*

By John W. Love, *Business Editor*
The Cleveland Press

As a journalist in these days I am necessarily a consumer of statistics. It is perhaps fitting that with the rise of consumerism in recent years, the middlemen and ultimate customers of statistical output should have greater recognition in the market.

There may not be half a dozen members of the American Statistical Association who like myself are solely consumers, producing or processing no statistics of our own but using only the work of others. I do not even print statistics in my business column in the newspaper any more than I can avoid, but I must habitually employ them in its preparation.

Although some of my best friends are statisticians I might remark that I think their product should be kept in its proper place, as inconspicuous as possible, so far as the public is concerned. Most consumers, I regret to admit, use statistics mainly to prove ideas they possess before they look for the evidence. This fault has even been detected in newspapers, I have been told, though it is probably less often noticed on the financial pages than on some others. It may be that no small share of our difficulties of these times has been due to the rise of technological improvement in statistics without a corresponding growth of wisdom in their presentation.

I have heard newspaper editors say the public was not interested in statistics, and I know of one editorial writer who lost his job because his work was "too statistical," according to the editor. The fact is, however, that the newspaper public has been consuming large quantities of statistics for decades—on the financial and sports pages. One great editor was himself so interested in statistics, though always as a layman or consumer, that he endowed the Scripps Foundation for Population Research.

The quantity of statistics is now so great that we ought to be devoting more thought to its packaging. Industrial statisticians, one notices, now admit the existence of the problem of getting the company presidents and vice presidents to read what they produce. It is pathetic but true that corporations will spend many thousands of dollars in statistical research and sometimes nobody but the statistician will read what he turns out. In years to come statisticians may reach the point of being

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

able to discuss openly how to induce executives not only to read the product but to base their action upon it.

One of the oldest sources of the statistics consumed by the public has been the Census Bureau. Evidently the Directors of the Census many years ago saw the value to the public of presenting their information in standard form, varying little from census period to census period. Decade after decade the press releases and the subsequent publications carry the information in the same language and in the same places in the tables. Whatever may be said from the statistician's point of view concerning the dangers of such standardization, the newspaper man is likely to assert the value of the rigidity of form. It facilitates comparison.

There are, no doubt, plenty of instances where lack of initiative on the part of issuing agencies and their unwillingness to change forms have prevented our getting information we have long needed, and I suspect the habits of journalists are to a degree responsible for the reluctance to change. At a time like the present, when a quantity of material is coming from the Census Bureau, the user soon learns the style of the page of preliminary or press release, and this familiarity aids him in its interpretation. I suppose the statistician needs to keep in mind the value of modernizing his material at the same time he maintains as much comparability as possible, requirements that would often call for ingenious adaptation.

We have in Cleveland a monthly report of employment in 100 large factories, compiled by the statistician of the Chamber of Commerce. This report has followed almost the same form since 1921. Its extreme standardization is one of the merits which have gained for it a steadily greater interest. Probably twenty different newspaper men handle it in the course of a year, but mistakes are almost never made in its interpretation because so many are now familiar with it.

Most census material which reaches the public initially is carried on the wire services from Washington, and the problem of statistical presentation on these first announcements is the simple one of suiting it to the uses of three or four press organizations. There follow by mail the summaries of preliminary information. Some of them are printed on one side of the paper and their tables can be cut and pasted into articles. The releases are not written directly for publication, however, and I think that is to be commended. Most newspapers rewrite what comes to them by mail anyway, and the practice which some organizations follow of trying to put their statistical material directly into article form and newspaper language I think is often unnecessary.

The office of the Secretary of Labor in Washington might well learn something from the Census Bureau in regard to the presentation of statistical facts. Each month Miss Perkins gives out to the newspapers a lengthy report on employment. Unlike the press releases of the Census Bureau this statement carries no title. One must read the first paragraph to discover what it is about. It is written in such a way that it can be sent directly to the printer, after adding a headline, but it is multigraphed on both sides of the sheet. It quotes the Secretary directly for a page or more, then drops the quotes. The use of the quotation marks, as well as some items of newspaper style, makes one suppose the compiler thinks the newspapers will use it directly for printer's copy, and yet the fact he economically employs both sides of the page makes it clear he does not.

Before the reader gets even a little way into this long statement of increases and decreases of employment by localities and industries he realizes that it is something from which readers are expected to extract the material they can use. Many offices might therefore wish to file it, but the foolscap length makes folding necessary in most office files. The length of the tables apparently dictates the length of the pages, but the Census Bureau resolves this little dilemma by reducing the size of the typewriter type by what I suppose is the planotype process. One of the beauties of the census releases is their standard size, fitting neatly into a letter-size folder.

The releases of the Census of Manufactures follow a form which has been similarly standardized and is suitable either for publication directly (in part) or for filing. I could wish the Census of Manufactures would report separately the industries by counties, in addition to cities, instead of those reports for what are called "industrial" districts. Just how some of these industrial districts are selected it is hard for me to see, and for the one with which I have the most experience—that consisting in the census reports of Cuyahoga and Lorain Counties in Ohio—the grouping is all but useless. The trouble with separately reporting the industries both by cities and counties would be, of course, that many concerns in the suburbs of the principal city would have their operations disclosed by mere subtraction. Even so, it is questionable whether some of these so-called industrial districts are worth the effort of their assembling.

The Census of Distribution is a service whose value the newspapers and the public are yet to appreciate in full. Even the statistical departments in the business offices of newspapers do not use its reports as much as they should. Perhaps there is room here for some public-rela-

tions work on the part of the Bureau. I suspect the Bureau could add to the value of this facility by computing and publishing more ratios. Business men, as we all know, employ many ratios in their work, and if national, state and city ratios could be computed for the separate lines of business they would save the user a good deal of figuring. The ratios of special interest to retailers obviously would be those of operating expense to sales and of payroll to sales or to operating expense. I believe the Census of Wholesale Distribution uses a ratio of operating expense to sales, and the same could profitably be extended for the Census of Retail Distribution. Making these ratios available and giving publicity to their presence might increase the demand for the material.

Some of the newer agencies of the Government have not had the same reverence the Census Bureau possesses for the more austere canons of statistical presentation. Even a layman's respect for government statistical work may suffer when he examines a report like that on Consumer Incomes in the United States, published two years ago, and discovers that incomes are distinguished first by tenths of the population then by thirds, and again by tenths, and finds, moreover, that the three-thirds of the Nation first include those receiving relief and then the nonrelief families alone, and finally that the categories into which the three-thirds are divided for statistical analysis are not the same as those into which the ten-tenths are divided. The writer of the report on Consumer Incomes had to admit that averages of incomes did not mean much for the top third of the Nation, and that as between country and city life the dollar figures do not give a true picture of variations of income among the American people. The inclusion of these admissions was to have been commended, of course, but the reader of the report had to suspect the use of so unusual a segregation of data as in national *thirds* was due mainly to the fact that President Roosevelt had chosen not long before to allude to the one-third who were ill-clothed and ill-housed. The effect of this report was clouded by the suspicion it had been brought out to prove something.

A good many producers of statistics seem to think it is important to have their material rewritten into newspaper language before it is offered to the newspapers. They go to the expense of hiring publicity men to write what we call "leads" on some of the simplest of statistical announcements. Practices differ within the same organization. For example, General Motors regularly issues from its Broadway office in New York a tabulation of the General Motors-Cornell weekly index of commodity prices. It consists of nothing but the title and a table. That is enough. Other material comes to the financial desk of a news-

paper from the same corporation with long explanation of what the figures mean.

I am inclined to doubt the value of much of the rewriting which some statisticians seem to think is necessary. A summary is valuable, of course, when the work runs to considerable length. Perhaps if statisticians could be sure their product went to the same persons month after month they would not undertake it. Some inquiry on their part as to who customarily receives the material might be useful.

I have long admired the simple and clear form in which Stanley Hunt's Textile Economics Bureau presented its figures on monthly shipments of rayon yarn, and thought he was one statistician who knew what newspapers wanted and did not go to the trouble of dolling it up for us. I wrote him, and learned to my surprise that he has a publicity man take his monthly figures and write a short article about them. This is Mr. Hunt's explanation:

> I think it is probably true that the typical statistician-research worker approaches his writing on the basis of developing several facts and working from these facts to a conclusion. In most instances the conclusion is stated at the end of his article or paper.
>
> On the other hand (I should be telling you), the newspaper story starts out with the most important conclusions and "works backward" so to speak. While I am fully aware of this newspaper technique, I find it difficult to put into practice. On the other hand, a regular newspaper man can do this very easily.
>
> A second point involved, in our case at least, is the fact that here at the bureau we get mistaken ideas about just what news is. We sometimes become so engrossed in our writing here that we probably do not have the proper perspective on the newsworthiness of a given article.

Perhaps there is indeed a subdivision of the art of journalism in the handling of statistical material, and perhaps there is a small field for the statistical journalist. There may be a division, even an antithesis, between the ability to derive statistical truth and the ability to present it in an interesting manner. Be that as it may, I suspect that statisticians would pick up the rudiments of the art with little trouble.

Would it not be possible for some of them, if they desire publicity, to apply their own statistical method of sampling to the question of what newspapers and other publications want? By trying various methods of presentation and then comparing the clippings from each venture it would not take them long to see which ones are most effective.

The effort on the part of statisticians to make their product "popular" has its pitfalls. Some of them undertake it, even in government service, as if the tenure of their jobs depended on the number of times

the office was publicly mentioned. Many do in private work, or their employers do, seeing in their material the means of obtaining favorable "institutional" publicity. Properly handled, these releases may be thoroughly worth the effort, but the suspicion that the figures are being prettied up for publication is easily aroused. It would be much better, I am sure, to give out the information in its raw form with a few words of explanation than to attempt an exposition at a length which might inadvertently make it clear to the prospective user that the statistician's purpose was not the scholarly disclosure of truth but the hope of getting free advertising.

Some of the most egregious errors all along the line, from the derivation of statistical material to its public presentation, are made by officers of taxpayers' committees which have sprung up in recent years. The field of their activity is in considerable part statistical, and a clear and forceful presentation of their case is imperative. Data on public expenditures are necessarily difficult and dull, and extraordinary effort is needed to make them readable. But if the information is inaccurate in the first place, as it sometimes is, readability may have a negative value. I could almost call it the civic duty of people in the statistical profession to warn the inexperienced backers of such organizations against the dangers of using untrained people.

This work, important in many communities, is most likely to be carried out properly if it is entrusted to well-established civic organizations which expect to be in business a long time, and to men who know the statistical profession in the field and can call on its members for advice.

Something probably ought to be said from the consumer's point of view concerning the use of charts, but the literature in that field is pretty large. For newspaper purposes the simpler the chart the better, as a rule, not merely because the reader's ability to use a chart is pretty close to that of the average man, but because few newspapers can afford to employ specialized draftsmen of charts. They often dislike to publish material which newspaper readers see at a glance came from outside the newspaper office.

It is not personal preference alone which leads me to say it is wise to use as few statistics or statistical tables as possible in the running statements of an article, and then separately to group the evidence either in tables or charts or both. This is emphatically best for newspaper publication because of the difficulties of making up into columns an article which includes tables as part of the running text.

Colonel Leonard P. Ayres' Monthly Bulletin of the Cleveland Trust Company seldom has figures in the text, even writes out dollar figures

in words, and practically never carries any tables. The evidence to support the statements made therein is carried in the charts, and the charts are clearly labelled and the sources of their information are always given. A part of the public following of that Bulletin has been built on the ability of the general reader to follow it clearly.

Tables of figures may be used in certain articles for general publication, of course, but even in this Journal I like those articles best which state the conclusions the writer is drawing from the statistical material which is presented separately. The tables may be printed in the body of the article, to be sure, taking elementary care to number the table and cite it at the proper place. Even the headings of the tables, as well as the headings of the charts, might well make it clear what they are intended to present. The reader of that kind of article can derive some of the meaning merely by looking at the charts, or at the headings of the tables, or he may read the article and never examine the tables, taking the writer's word for it that the tables support his conclusions. This method may result, of course, in the writer telling his story twice or even three times, but is this to be deplored?

I was discussing this point with Whiting Williams, the industrial relations consultant. He said statistical writers can seldom go wrong, he thought, in telling the same thing in many different ways, at least if they are writing for the layman. Too often, he thought, statisticians seemed to believe that because they had gone to a lot of work, the reader ought to do the same.

People who undertake to present statistical truths to industrial workers in large numbers need especially to be wary of double risks—those on the one hand of confusing the readers or making it difficult for them, and on the other of seeming to write down to them. The device of presenting the statistical evidence separately, for those who want to go farther into the reasons the writer thinks as he does, is probably a good one to follow in that type of communication.

In conclusion I cite what a friend of mine in Chicago wrote me, a man who is with one of the largest corporations there:

> Like yourself, we are not statisticians but we are frequently called upon to interpret statistics. We try to approach our interpretations with two distinct objectives in mind: one, that the statistics must be fundamentally honest and sound, and, two, they must be presented in such a way as to be understandable by the general public. It seems to me that unless statistics meet both of these requirements they are not only useless but tend to spread misinformation and confuse the thinking of the people, defeating the very purpose of clarification and understanding which statistics should promote.

PROBLEMS CONCERNING THE AVAILABILITY OF CENSUS DATA*

By Halbert L. Dunn, M.D., *Chief Statistician for Vital Statistics United States Bureau of the Census*

A few weeks ago I saw an animated cartoon called "Willie the Flea." Willie, a brisk businesslike little chap, was looking for a new home. With his worldly possessions wrapped in a red bandana handkerchief and slung over his shoulder, he entered a large estate, marched to the huge front door, scrambled through a crack beneath it, and then spied the family hound asleep by the fire. With a gleeful hop, skip and jump, he landed squarely on his goal and sank beneath the protective surface of soft white hair.

From this time on, the film was a play between two viewpoints—that of the dog who awoke with a start from his sleep, knowing that something uncomfortable was happening to him, and that of the flea who in an objective sort of way busied himself to insure his comfort. The thought startled me as I sat fascinated, watching Willie wander between huge shiny tree trunks, which were magnified dog hairs, that while I had observed many times the bizarre scratchings of a dog with a flea, I had never before considered the state of affairs from the flea's standpoint.

Understanding is a fragile tie at best. Too often we say we understand when actually what we do is observe. We put our Willie under the microscope instead of imagining how we would feel if we were a flea with a flea's outlook on life. Occasionally, while writing a difficult letter, I have taken the final draft to a colleague and said, "Pretend that you are Mr. So-and-so, crusty of disposition, with a grudge against the Federal Government and a particular dislike to vital statistics and tell me how you would react to this letter." This little game of make-believe pays dividends in understanding.

The problems involved with making census data available to the public are primarily psychological ones—largely involved with understanding the other chap's viewpoint. True, there are plenty of headaches in terms of budget, publication, analysis, and presentation of statistical material. But these things can be solved by buying trained brains and skilled hands, by turning them loose to do a job the best they can. But to understand the audience for this material is a more difficult matter—one which is hemmed in by barriers of ignorance, indifference, distance, and prejudice. If the Bureau is to reach its audience

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

and make its data truly available, its primary task is to understand the people whom it would serve, and whose needs it desires to satisfy. It must interpret its data in the light of what *they* are. Of how *they* live and feel and dream. In no other way can the gap be bridged between supply and demand.

The Bureau's difficulty arises from the variability of its audience. Most agencies publishing statistics would at least have a subject matter field in common with specific interests of the people whom it sought to serve. The subject matter field of the Census Bureau is the American people; of all ages and races; of both sexes; of every degree of education and intelligence; of every type of social interest; of every variety of occupational specialization. All types of organizations with their special needs are represented.

To fill the needs of such a varied audience, the Bureau has available tabulations on many subjects such as: Population and citizenship, schooling and illiteracy, occupations and employment, family and housing, business and manufacturing, taxation and agriculture. The Division of Vital Statistics is attempting to serve a public which is almost as variable. However, the Division benefits by more sharply defined fields of interest in its audience, particularly those relating to public health and social security. The needs can be largely answered by data on birth and death, sickness, marriage, divorce, fertility, and hospitalization.

Let us consider the users of census data. Let us try to understand *their* needs for factual information in the way that *they* would express it.

Everyday life varies from community to community. The interests and outlook of the Kentucky mountaineer differ considerably from the blue grass country gentleman. The Negro of Mississippi is not the Negro of Chicago. The rancher from Colorado could well be the citizen of a foreign country to the farmer from Maine. A youth of seventeen has everything before him—the feeble man of eighty, everything behind. The youth seeks opportunity; the aged, security and peace.

These considerations bring with them the conclusion that census data must be assembled in small packages, containing information suitable to the particular interests of those types of persons who will probably use them. In the Division of Vital Statistics, we have experimented with the possibility of publishing our data in just such small packages suitable for satisfying especial interests.

In January 1936, the Vital Statistics-Special Reports series was established. By means of this series it became possible for us to publish statistics from six to nine months earlier than ever before and at the

same time to tailor-make publications of such statistics to fit the needs of special groups. By a survey of all requests coming to the Division new releases were planned which would answer the practical questions contained in letters and queries.

A few of the principal advances arising from the requests coming to the Division are:

a) An analytical study conducted to evaluate the accuracy of current natality and mortality statistics. On the basis of this study, the reporting procedures for the Monthly Vital Statistics Bulletin were redrafted in order to improve the accuracy of current information on births and deaths.

b) Analytical studies of motor-vehicle accident fatalities made to determine the difference between accident statistics tabulated by place of death and by place of accident. This has resulted in a new reporting system for motor-vehicle accidents.

c) Increased usefulness of current reports, Weekly Health Index, Weekly Accident Bulletin, and the Monthly Vital Statistics Bulletin by the inclusion of rates for 1941. For the first time, it is possible to compare current vital data for the various cities or states.

d) Revision of State Summaries for 1939 to include additional tabulation and also a brief analytical abstract to highlight the interesting vital facts for the state. The 1940 State Summaries will probably be further revised so as to contain more data based on rates than ever before.

e) Increased number of releases on special subjects; cancer, pneumonia, tuberculosis, accidents, infant mortality, maternal mortality, etc., published in the Vital Statistics Special Reports series. This type of release makes data available about a year before they could be published in annual volumes, and makes for wider distribution.

f) Consolidation of all available statistical information on certain selected causes of death to be made available in 1941 as four-page releases.

g) Plans for county releases in which basic information relating to vital statistics and pertinent socio-economic data will be given.

h) Preparation in non-technical language of publications dealing with vital statistics.

i) Increased use of graphic methods in presenting data.

j) Efforts to improve appearance of reports by use of new format, varityper, layout, etc.

k) Devotion of much time and effort to the preparation of material in answer to requests.

l) Use of requests received to determine the publication of what data can best fill "popular" requests.

m) Critical review of our own publications.

n) Organization of our mailing list so as to serve more fully those groups having special interests.

The tailor-making of vital statistics publications for public need is still in the planning stage. Even so, we hear not infrequently the question from some scientist or public health leader, "How do you manage to publish in your series just exactly those tables which contain the answers I want to know?" Our reply, of course, is "You have built these tables yourself. Rarely does a new tabulation find its way into the series that does not arise from your practical questions."

To analyze requests for data from incoming letters is not enough. Rarely does one question in a hundred, formulated in the mind of the citizen, become crystallized in letter form. Not one need for statistical data in a hundred materializes in form so concrete that it can be consciously expressed by a verbal question. To understand the need, we must think and live the thoughts of those whom we serve.

An analysis of the "best sellers" in the Government list of publications shows that they have certain characteristics in common. Most of them are handbooks or guides to some important problem which people face. "Infant Care," published by the Children's Bureau, is an excellent example. Over 12,000,000 copies have been distributed. Why? Because the pamphlet is well written and packs a lot of information in a convenient form so that health workers, doctors, and nurses prescribe it as they would a bottle of medicine.

The Division of Vital Statistics has been experimenting in redesigning not only its statistical reports, but also its entire field of approach to the general public. Faced with the problem of a serious under-registration of births in the rural communities and possessed of a total field staff of just four people, there was no alternative to surrender, except complete reorientation of the field techniques. The decision was to try out a registration campaign which was completely integrated with community interests. The state selected for the original trial was West Virginia; the time chosen the first week in October 1938. Preparation went on for three months prior to the campaign. All state organizations were studied which ramified in their structural design from state to county sub-units. These organizations included parent teachers' associations, health departments, medical societies, women's clubs, American Legion posts, churches, etc. Talks and lectures on birth registration to fit each type of audience were prepared. The one to a mixed farm

OUTLINE OF MORTALITY

	Tabulation	Cards Included	Geographic Location: Selected States for race breakdowns	Population Groups: Cities of 10,000 +, Rural	Population Groups: Cities of 100,000 +, 10,000 +, 2,500 +, Rural	Population Groups: Cities of 100,000 +, 25,000 +, 10,000 +, 2,500 +, Rural	Each County or City of 10,000 +	Individual 100,000 + Cities	Selected 100,000 + Cities for race breakdowns	Cause of Death: Detailed List with Letter Subdivisions	Detailed List with Letter Combinations	Selected Causes[1]	Infant Cause List
Place of Death	1	Each State		1			a						
	2	Each State				a							
	3	Each State				a		b		1			
	4	Each State									1		
	5	Each State										1	
	6	Each State—Infant deaths		1			a						
	7	Each State—Infant deaths			b			d					1
	8	Each State—Non-resident deaths		1			a						
Place of Residence	9	Each State—Non-resident deaths		1			a						
	10	Each State				a						1	
	11	Each State—Cities of 10,000 to 100,000	1				a					2	
	12	Each State—Rural and rural cities	1				a					2	
	13	Each State—Cities of 100,000 +						1	2			3	
	14	Each State	2	1			a						
	15	Each State—Infant deaths			b			d					1
	16	United States—Exclusive of white persons									2		

[1] There are two Selected Cause lists, one used for Tabulation 5, and the other, differing in causes included, for Tabulations 10, 11, 12, 13.

Note.—Sorts are indicated by numbers in order—1, 2, 3, etc. and counts by letters in order—a, b, c, etc. In each tabulation all *numbered* subjects are crossed with each other and with all *lettered* subjects; *lettered* subjects are not crossed with each other except where the same letter appears for two subjects, but are crossed with all numbered subjects. More than one sort or count or a sort and a count for any one subject are indicated by the appropriate combination of numbers and/or letters in the corresponding cell.

group started with the sentence, "Nearly all farmers realize the value of well-bred livestock," and then went on to link birth registration to the registration of pure-bred stock. The campaign plan included in its list of talks a sermon incorporating registration facts gleaned from the Bible. This was preached from scores of pulpits. State leaders were urged to give all credit for the campaign to county leaders.

Was the campaign successful? It swamped the State Health Depart-

TABULATIONS 1930

Age			Race and Nativity						Sex	Institution			Marital Condition	Month of Death
		Infant												
Under 1 yr., 1–4 yrs., 10 yr. age groups to 84, 85+, unk.	Under 1 year, single years to 4, 5 yr. age groups to 99, 100+, unk.	Under 1 day, 1, 2, 3–6, 7–13, 14–20, 21–29 days, 1, 2 . . . 11 mos.	White, Other	White, Negro, Other	White nativity, Negro, Indian, Chinese, Japanese, Other	Other (excl. White)	Negro, Other (excl. White)	Negro, Indian, Chinese, Japanese, Other (excl. White)	Male, Female	No institution, Nonresident institution, Resident institution	Type of institution, in detail	Type of control, in detail	Single, Married, Widowed, Divorced, Unknown	
				3						2				
	a				2				1		c	d	c	b
				a, b					2					
	a, c		b			c		d	2					
	a		2						3		c	d	c	b
				2										
		2	b, d	a					a					c
				3						2				
				3						2				
				a					2					
			1						3					
			1						3					
	a		2						4		c	d	c	b
2			3											
		2	b, d	a					a					c
	a						1		3					b

ment for months with requests for checking and registration. It left the State seeded in almost every county with prominent citizens who were interested in the subject. Their interest arose because they had participated—because the entire county effort had been credited to their leadership.

One of the lessons learned from this campaign and others of kindred nature was the tremendous local interest in everything which concerns one's own city and one's own county. Most national organizations of any great strength ramify through state branches into county or city chapters or societies. The consequence is that local interest in all facts

about one's own county is something in which practically everyone participates.

For instance, I recall how surprised we were several years ago when we observed that two shaded county maps of the birth and death rates from the State of Texas "stole the show" from other Census Bureau exhibits. We would have rated the maps among the least interesting of all the Bureau's exhibits. However, the demonstrator told us that almost every person coming to the booth immediately looked on the maps so as to locate his county and determine its relative standing with other counties or with the state as a whole.

Because the Bureau of the Census has come to realize the importance of this interest in county data, it plans and hopes to be able to issue county releases which will include the principal results for the 1940 Sixteenth Decennial Census. Such county leaflets will permit a wide popular distribution of the census totals and other information most frequently requested, and at the same time should reduce the use of the more expensive bulletins and volumes. The leaflets could be purchased in bulk at insignificant cost from the Superintendent of Documents for use in local conventions, schools, and other groups and institutions. They will probably be used extensively by county officials, agricultural agents, and other persons interested in civic affairs, and by persons wishing to have the standard-list items for large areas including many counties, such as the Ozark region, the Mississippi delta, or the TVA area.

To accompany the county leaflet series, it is planned to have a small United States pamphlet carrying the identical stubs used in the county leaflets, and giving such data for the United States as a whole and for each state.

It is realized that these releases will be but a first step in making Census data available psychologically as well as physically to the American public. A score of other types of tabulations are needed almost as urgently.

One request which reappears time and again in the letters of the Division of Vital Statistics is the need for a simple index which will show what data are in existence. This request assumes particular importance when one realizes that a very small fraction of the data attainable in tabulations is ever reduced to printed tables for publication. Only the tabulations which seem to be the most important can be published by the Bureau.

The Division of Vital Statistics has experimented with algebraic methods of indicating what is available in its original machine tabula-

tions, its volumes, its special report series, and its unpublished tables. An unusually high concentration in the index can be achieved by the algebraic method.[1]

The Division expects to publish algebraic content indices such as these each year for the data which are available. Later, it hopes to index all data which it has published at any time.

[1] The basic principle of this index is that a number under an item means that that item is crossed with every other item in the tabulation, while a letter signifies that it is crossed only with all numbered items. The mortality tabulations of 1930 are reproduced in the table. These involve almost 20,000 sheets of data. Tabulation No. 7 is by place of death. Each category of the entire infant death cause list, about fifty in number, is tabulated for the infant age breakdown of under 1 day, 1 day, 2 days, 3–6 days, 7–13 days, etc. Each of these breakdowns in turn is tabulated (1) by urban and rural population groups crossed with race (white and "other"), (2) by individual 100,000 cities crossed with race (white and other), (3) by race (white, Negro, and other) crossed with sex, and (4) by month of death. The (b, d) under race (white and other) indicates that the information for individual cities and for population groups is also broken down for white and other races. The (a) under the race item (white, Negro, and other) and under the sex item indicates that these items are cross tabulated.

OBSERVATION ON CORRELATION ANALYSIS

By A. H. Mowbray, *University of California*

The recent controversy between Messrs. Malenbaum and Black, on the one hand, and Messrs. Bean and Ezekiel, on the other, over the use of the short-cut graphic method of multiple correlation[1] seems to have closed without agreement on definitive principles by which investigators may be safely guided in the use of such a method, and there has been introduced through a footnote an implied approval of the assumption that true regression surfaces may be found from "samples which are not random and are taken from a universe the independent factors in which may be changing from observation to observation."[2] This situation may be an indication that in the rapid extention of the use of correlation analysis and the development of alternative techniques, there has been a tendency to forget or ignore the fundamental definitions and assumptions of correlation analysis and the limitations following therefrom. It is the purpose of these notes to hark back to those fundamentals to see if from them rules or tests may not be developed which may serve as safe guides in the use of the newer techniques.

The concept of correlation analysis from which we begin is that it is an aspect of logical induction, a means of testing hypotheses. We draw a distinction between an hypothesis and an empirical generalization, in that the former is susceptible of explanation or rational interpretation in the light of already established facts and relations and the latter is merely a generalized statement of observational results. An empirical generalization may lead to hypothesis or it may not. An empirical statement, especially if graphic, may be so particularized as to lose generality and yet in such a way that only test on a broader basis will establish the loss of generality. Particularization of an hypothesis which must be expressed in words or symbols tends to expose itself immediately by its necessary elaborateness exactly to describe its particular form. From these considerations, it would appear that the first requirement for validity of any correlation analysis is a rational explanation of its regression equation.

It is not necessary that the hypothesis be fully developed before the correlation study is begun. It is, of course, necessary that the variables presumed to be related be known so that associated values may be observed. But this is sufficient at the outset. The character of the association may be developed by the study.

[1] *Quarterly Journal of Economics*, LII, pp. 66–112, and LIV, pp. 318–361.
[2] *Ibid.*, LIV, 358.

It would seem, however, that if results are to be of any utility a logical explanation of the form of the regression expression, be it equation or curve, must be found. Otherwise, it would seem the result must stand as an *ad hoc* representation of a particular set of observations and of very doubtful, if any, application beyond that point, regardless of the numerical value of any correlation coefficient found. If no rational explanation of the form of regression can be found, what reason can be adduced for thinking another sample would yield a similar result? On what rational grounds may it be assumed that the regression found over the investigated range will obtain at any point beyond that range? In the absence of a logical explanation, generalization of the regression found would be a mere *ipse dixit*.

This seems to be a first general principle to guide the user of either "flexible" or "inflexible" methods of correlation analysis. Indeed, from this point of view the only difference between flexible and inflexible methods is that the former demands that the hypothesis be developed in advance or at least as curves are modified, the latter is willing to allow the best fit of lines (straight lines, second degree parabolas, etc.) to be found before working out the detail of hypothesis.

In the graphic method one should assume a range of possible regression curves or surfaces which logically may be expected to express the relationship existing between the several variables. Hypotheses corresponding to such curves or surfaces should be developed to explain the relationships represented and each curve or surface tested to show which best fits the available data.

If the data used are adequately representative of the universe (and only under this condition should it be used as a basis for generalization) it may be used to determine the particular curve or surface which gives the best reasonable explanation of the relationship.

What constitutes an adequate test of any hypothesis is a question not susceptible of precise answer. In the physical sciences even so-called "laws" are held as no more than working hypotheses or approximations to be abandoned or corrected as the weight of new evidence indicates. Even though not going so far as this, probably no careful investigator would give much credence to any hypothesis the test of which had been less extensive than that imposed by a random sample of the entire universe to which it pretended to apply. If the sample were small he would also demand consistent results when the sample is broken randomly into parts and each treated as an independent sample. Even under this test the degree of credence should be further restricted in accordance with the indications of the recognized

probability tests for chance errors. If there is no stable (within the limits of the hypothesis) universe by which it may be tested, what has the investigator or the student considering the hypothesis upon which to base a judgment? Can we accept the proposition that it may be tested by considering its application, in a correlation analysis of "samples which are not random and are taken from a universe the independent factors in which may be changing from observation to observation?" We think not. However much it may be desired to study such samples as particular economic or social problems, the correlation analysis, as a technique of testing hypotheses, hardly seems an appropriate tool. It is true that the mechanics of that analysis may be applied to such conditions but the results appear to be no more than abbreviated descriptions of the particular data. This, then, seems to be a second general principle suitable as a guide for the users of correlation analysis.

Tschuprow, in his *Principles of the Mathematical Theory of Correlation*[3] distinguishes sharply between "Stochastic connexion and functional relationship between variable magnitudes." By functional relation he means what is ordinarily referred to as a law, that is, a completely reversible statement of quantitative relation between the values of two or more variable magnitudes, so that all but one being given that one may be precisely determined. By stochastic connection, he means such a relation between the so-called "dependent" variable and the "independent" variables that when the latter are given, a frequency distribution of the former is found to correspond. The difference is between exact value and a range of values of varying degree of probability. The complete universe whose properties are sought by correlation analysis may be considered, *a priori*, as a joint frequency distribution, such as would arise from the superposition of chance perturbations upon the forces setting up a functional relation between a set of variables. The problem of correlation analysis is the approximate description of that *a priori* joint frequency distribution by the use of coefficients derived from an empirical sample, which coefficients correspond to the theoretical coefficients of the *a priori* distribution. Under this approach the regression line or surface is an approximation to the expression of an underlying functional relation, perturbation of which by a multiplicity of other forces gives rise to the joint frequency distribution. The joint frequency distribution will be of high or low dispersion depending upon the joint potency of the perturbing forces, its symmetry or skewness will depend upon their relative potency.

Geometrically, then, the regression expression may be thought of as defined by a shell or part of shell in n-dimensional space, and the theo-

[3] Translated by M. Kantorowitsch, Wm. Hodge & Co., London, 1930, Chap. III.

retical data described by the *a priori* joint frequency distribution as cloud of points distributed around this shell with decreasing density as the distance from the shell increases.

With this concept in mind we may turn to the fundamental equation of the correlation analysis, that for the coefficient of determination,[4] which in its most general form may be written:

$$\rho^2_{y.x} = 1 - \frac{S^2_y}{\sigma^2_y},$$

where σ^2_y has its usual meaning and S^2_y is the mean of the squares of the deviations of the observed values of y from the computed values, and ρ is used to indicate that curvilinear multiple relations are included.

It may first be noted that this equation presumes a "least squares" fit of the regression function, for otherwise by substituting such a fit a lower value of S^2 and higher ρ^2 could be found. In the ideal *a priori* joint frequency distribution the regression function passes through the mean of each array of the dependent variable. It may not do so as to the distribution of the observed data due to chance variation of limited numbers. In practice, as indicated by Bean and Ezekiel the minimizing of the squared residuals may be worked out by a trial and error approach, but this approach is subject to our first principle stated above that the regression expression must represent a rational hypothesis.

Although in the first stages of the development of correlation analysis it was assumed that the dependent variable must be normally distributed, that has been shown to be unnecessary. Indeed, if it were so, then the technique could not be used to analyze the variation of a variable whose relation to other variables was other than linear.

What may be said of the residuals whose mean square is S^2? Two cases may be considered. In the first it is assumed that the volume of data is practically unlimited. In that case it would appear that if the regression expression accounted for all systematic forces affecting the dependent variable, the residuals would form a normal distribution, not only as a whole, but in each array. For, if all the systematic forces are accounted for, then the remaining variation will be due to that complex of variable forces we subsume under the term "chance." Theoretical analysis and experimental observation seem to confirm each other that the variation so produced does tend to take the form of a normal distribution. If, with practically unlimited data, the distribution does not tend to be normal both externally and internally it would appear the analysis is incomplete. Either all the important forces influencing the

[4] From what has been said above it is probably evident that this writer regards the regression equation as the real fundamental equation. But this cannot be discussed further in general terms.

dependent variables have not been taken into account or the form of regression expression used does not correspond to the true underlying functional relation.

In the second case, where the data are limited, as Student and others have shown, it cannot always be expected that the residuals will tend to form a normal curve. It would appear, however, that not only should the sum of the residuals be zero, a concomitant of minimized squared residuals, but it should likewise be approximately zero for each array if the data are not broken into too fine classes. Any considerable piling up of residuals either positive or negative over considerable sections of the range should give rise to suspicion of an erroneous regression expression. This is probably most apt to appear when a rectilinear relation is assumed, for it is then one of the indicators of curvilinear relation.

At all times we may be guided by computation of error coefficients and their probability interpretation. If the sample is limited in volume and the chosen regression expression is complex the remaining degrees of freedom may be so few as to give a wide range of doubt for the acceptance of the regression expression.

Finally we may revert to Tschuprow's emphasis on the correlation analysis as a means of studying stochastic connection, i.e. functional relation modified by chance forces, and view the correlation coefficient or coefficient of determination from that point of view. If the data are not the result of such closely controlled experiment that chance variations are greatly reduced, too high a coefficient becomes suspect because it does not leave sufficient room for the play of the chance forces which, in the absence of such close control, our common experience tells us will be present.

To summarize: From the fundamental definitions and assumptions of the correlation technique it appears there may be deduced the following criteria for judging conclusions based on its use either by "flexible" or "inflexible" methods:

1. The reasonableness of the regression equation as a statement of relation in the sense of a working hypothesis or law as distinguished from an *ad hoc* descriptive expression of a particular situation.

2. The adequacy of the sample for the testing of an hypothesis, both as respects its size and the manner of its selection.

3. Within the limit of the first criterion, the approach of the squared residuals to a minimum.

4. The reasonableness of the distribution of the residuals as resultants of unconsidered forces.

5. The reasonableness of the measure of correlation in the light of what is known of possible effect of unconsidered forces.

CORPORATE EARNINGS ON SHARE AND BORROWED CAPITAL IN PERCENTAGES OF GROSS INCOME (1918–1940)

By Leland Rex Robinson*

In this journal for March, 1934, and again in September, 1936, there appeared articles under the same title whose charts and tables contained percentages of earnings for the entire period following World War I through 1932 and 1935 respectively. It is now possible to carry forward all of these figures through 1938 and some of them through 1940, thus giving us nearly a quarter-century view of the ability of American corporations to convert the "raw material" of their gross incomes into the "finished product" of earnings on capital, both borrowed and proprietary, utilized in business.

For a technical discussion of the statistical methods used, their advantages and limitations, and of other work in somewhat similar fields, the reader is referred to the earlier of these above-mentioned articles by the same author. Here the briefest recapitulation must suffice.

From the standpoint of the investor, the business man, and the banker the crucial question in connection with any undertaking is its capacity to convert gross income into net profit on capital employed. This capital includes both borrowed capital and share capital, and gross income comprises interest and dividends received and profit and loss turnover on securities owned, as well as revenues from ordinary operations. "Net profit" as used in Table I and the charts, differs from "net income" in the ordinary sense of earnings on share capital. "Net profit" as here employed is built up by adding to "net income" (after deduction of all taxes) all interest paid by the corporation on funded or unfunded debt.

It is evident that ratios of net profit to gross income (where net profit is taken as earnings, after taxes, on all capital employed, both borrowed and share, over the indicated period) are a more realistic gauge of business performance than are ratios of net income (taken as earnings on share capital only). With the former, changes in capital structure, such as alterations in proportions of borrowed and share capital, do not directly affect the ratios of earnings to gross income. With the latter these extraneous factors do have a direct and sometimes important effect upon such ratios from year to year. In other words, ratios of net profit to gross income would appear the better measure of business efficiency, considered of course from a purely acquisitive viewpoint.

* Note: The author has enjoyed the assistance of Florence Clark Beal of Washington, D.C., in the statistical compilations, and gratefully acknowledges her prompt and painstaking cooperation which has made possible going to press within a few days of the release of the 1938 Federal Statistics of Income.

TABLE

RATIOS (PER CENT) OF NET

		1918	1919	1920	1921	1922	1923	1924	1925
Total	All corporations*	8.5	6.5	5.0	0.1	5.1	6.3	4.5	5.3
	Representative corporations†	9.5	8.5	7.9	2.8	8.4	9.0	8.7	10.0
Mining and petroleum	All	9.3	5.4	7.3	−4.0	4.1	2.8	2.0	7.6
	Representative	19.5	12.3	12.2	1.8	9.6	8.0	9.1	12.8
Total manufacturing	All	8.2	7.6	4.9	0.5	6.0	6.9	6.0	6.9
	Representative	8.5	8.3	7.7	3.3	8.0	9.0	9.2	10.0
Food products, beverages and tobacco	All	4.2	3.6	2.3	1.1	4.4	4.7	4.5	4.0
	Representative	3.7	5.0	6.0	−1.6	8.6	10.3	10.3	8.0
Textiles and their products	All	0.4	9.6	3.1	2.5	7.1	6.7	2.7	4.6
	Representative	10.7	12.0	9.7	7.0	7.2	9.1	2.3	3.8
Leather and its manufactures	All	5.4	8.4	−1.5	−2.5	6.0	5.0	3.3	3.6
	Representative	7.9	7.3	3.3	5.0	9.1	7.7	8.7	8.6
Rubber products	All	7.4	8.8	0.3	−11.0	4.4	4.7	6.8	9.5
	Representative	9.2	9.9	6.2	−13.9	7.9	7.1	9.4	10.7
Paper, pulp and products	All	6.7	9.0	10.0	0.4	6.3	7.4	6.4	7.5
	Representative	....	....	....	4.7	11.4	15.3	10.5	11.0
Printing, publishing and allied industries	All	4.9	7.0	6.8	4.0	8.8	7.4	7.6	7.6
	Representative	−5.3	−3.2	2.2	9.6	6.9	7.8	6.1	7.8
Chemicals and allied products	All	6.5	7.8	5.5	1.3	9.3	7.7	8.0	10.2
	Representative	7.0	8.8	9.8	6.4	16.4	15.5	12.1	12.4
Stone, clay and glass products	All	8.4	9.6	8.9	4.0	9.9	12.4	10.6	10.6
	Representative	....	....	20.7	11.3	11.8	14.4	20.2	22.4
Metals and their products	All	8.8	9.9	7.6	−1.4	7.6	7.9	7.4	8.3
	Representative	9.0	8.6	8.6	6.3	8.5	9.7	9.0	10.4
Trade	All	5.7	5.0	2.0	0.3	2.9	3.3	2.7	2.0
	Representative	6.1	6.5	3.2	1.6	6.8	7.0	6.7	6.9

* Percentage of gross income available for interest and dividends after deduction of all taxes.

Net profit is used in the sense of earnings, after all operating and other costs and taxes, on all capital employed, including capital borrowed on long and short term. In other words, "net profit" as here used is equivalent to "net income" in the commonly employed sense (i.e., earnings on share capital) after deduction of taxes, with all interest paid added back in again. As proportions of borrowed capital vary from company to company, from group to group, and even from year to year, the ratios to gross income of net profit in this sense have more significance as a measure of efficiency and earning power than ratios based upon net income which is arbitrarily affected by changes in the volume and proportion of borrowed funds used in the business.

From another angle it seems wise not to omit such earnings as accrue to borrowed funds in computing the percentage of gross revenues coming through in the form of net. Only by taking earnings on all capital employed can the long-run capacity of enterprise to attract and wisely utilize savings be tested. To the extent that capitalization assumes the form of debt, net income on share capital alone must reflect the upward and downward leverage effects of prior lien fixed cost capital, thus distorting and magnifying any true picture of the ability of business to increase earnings during good times and its tendency to drop them during bad times.

Of course, earnings upon capital invested in the business are for this latter purpose a better indication than ratios of net to gross income. Capitalization, however, is sometimes as much a reflection of estab-

I

PROFIT TO GROSS INCOME*

1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1939§	1940§
5.3	4.0	5.3	5.0	2.5	−0.3	−2.8	1.3	2.7	3.0	4.4	4.1	2.2			
10.0	0.5	10.5	11.1	7.2	3.0	−0.7	4.3	5.7	7.1	8.0	8.0	5.0	7.3	7.0	7.0
8.6	4.3	7.1	0.1	2.8	−0.0	−7.5	−4.0	5.2	4.0	0.7	8.0	2.0			
12.8	7.8	13.0	15.0	7.2	−3.7	0.7	4.2	0.4	10.1	11.5	13.3	7.7	0.1	8.0	8.2
7.0	6.0	7.0	7.0	3.8	0.7	−2.7	2.3	3.0	5.3	0.1	5.0	3.1			
10.0	10.7	10.0	11.7	8.5	5.4	−2.5	5.1	0.1	7.7	0.5	8.2	4.0	8.0	8.3	7.0
4.0	4.2	4.0	4.8	4.2	3.2	2.5	3.0	4.5	4.5	4.7	3.3	3.4			
8.3	8.5	0.2	0.5	8.5	8.4	0.2	10.1	10.0	7.7	7.3	6.1	6.7	7.3	6.4	6.1
2.3	4.3	3.2	2.0	−3.1	−4.0	−0.4	2.7	0.8	1.0	3.1	1.7	−0.2			
0.4	8.4	8.7	7.5	−1.1	−0.7	−0.0	0.0	1.4	1.7	4.0	1.0	−2.0	4.0	2.8	2.1
3.2	4.0	3.4	2.7	−1.2	−2.0	−4.5	2.7	2.0	3.3	2.0	1.0	0.0			
7.7	0.7	8.7	8.4	7.3	7.1	6.0	7.4	0.0	0.3	0.2	4.0	3.4	4.0	4.0	4.8
4.0	5.5	2.0	3.4	−1.5	0.0	−1.0	2.8	4.4	4.2	5.4	4.2	3.2			
5.0	8.0	2.3	5.8	−0.2	1.4	−0.3	5.1	4.0	4.5	7.3	4.0	5.0	6.1	0.1	5.1
7.8	8.1	8.3	8.2	0.1	2.4	−2.4	4.0	5.0	5.0	0.3	0.7	3.8			
0.0	0.0	10.5	11.4	7.3	3.3	−0.2	3.4	0.4	7.7	8.2	10.0	3.5	6.4	7.8	7.1
7.0	7.7	0.1	8.8	7.0	3.4	0.1	2.0	4.1	0.0	0.8	5.7	3.7			
0.3	15.5	10.3	10.5	14.0	10.1	−1.7	−1.4	3.0	5.4	0.3	7.1	3.0	5.7	0.0	7.2
11.3	7.2	11.5	8.8	0.0	3.7	2.8	3.8	5.4	7.0	7.4	7.1	4.1			
14.3	15.0	17.0	10.2	15.7	13.5	15.5	15.4	15.0	10.5	20.0	20.0	15.2	10.7	15.0	15.1
10.3	8.3	8.0	8.4	3.0	−1.0	−11.0	−1.0	4.3	0.8	0.0	7.0	5.0			
18.8	10.8	10.0	17.2	10.1	4.2	−10.3	−8.3	8.2	8.2	15.0	12.0	8.7	10.0	10.0	0.0
8.0	7.0	8.2	0.1	4.0	−1.0	−12.2	−0.0	3.8	0.0	7.7	7.7	3.4			
11.3	11.2	12.1	12.8	0.5	4.5	−8.8	2.7	4.8	8.1	10.2	0.0	4.2	8.4	0.7	0.2
2.5	2.0	2.8	2.2	0.5	−1.1	−2.7	0.4	1.4	1.0	2.1	1.8	1.1			
6.0	7.0	6.7	5.0	3.0	3.5	1.7	3.1	4.0	4.4	4.0	4.3	3.8	4.0	5.4	4.0

† These figures are computed from *Statistics of Income*, Bureau of Internal Revenue. They include only those categories given in the table and corresponding to the categories of representative corporations.

‡ These figures are based upon analyses of reports of leading corporations. See Table II.

§ When this article went to press, only a "sample" of the representative corporations had made their earnings figures available through 1940 (See Table II). It was nevertheless considered advisable to include ratios for this sample. As these ratios are not strictly comparable with those for the larger number of companies included in 1939 and earlier years, ratios for the same companies as in the 1940 sample were calculated for 1939.

lished or prospective earning power as it is of funds actually at work in the business. In view of the devices of modern accounting and the confusion of legal with economic principles in write-ups, write-downs, surplus items, par and stated values, there is a degree of arbitrariness in statements of capital and in changes therein which does not appear in most figures of gross income, despite limitations in the accuracy of the latter.[1] It is interesting to observe, however, that aggregate capital invested in corporations apparently not only gravitates toward their annual gross income but tends to vary with it, so that percentage which net bears to gross is a very rough indication not only of earning power on capital employed, but also of changes therein.[2]

[1] See this Journal, vol. 29 (March 1934), p. 43, where it is pointed out that gross income as reported by many corporations is made up partly of net items.

[2] See footnote 2, page 483, of this Journal for September, 1939. Thus in the March, 1941, National

The principal source of figures on American corporate income is of course the annual volume on Statistics of Income published by the United States Bureau of Internal Revenue. While these statistics are by far the most complete and accurate available, they are nevertheless two to three years late in publication and throw little if any light upon current conditions. Therefore, in addition to using the federal Statistics of Income it has been necessary to develop series of comparable corporate statistics based upon analyses of the returns of individual corporations.

The number of individual representative corporations whose published reports may be utilized for this purpose is limited by reason of the fact that the great majority of American corporations have not been in the habit of publishing figures of gross income. However, it has been possible to pick out a substantial number of leading and representative corporations which do give the necessary data in their current reports, and to group these corporations into the same categories as those which are presented in the federal figures. In this way it is possible to compare the fluctuations in ratios of net profit to gross income in the two series. The results of this study are spread out in Table I. The average number of representative companies in each group, and the average percentage which their gross income bears to the gross income for all corporations in each corresponding category, as set forth in the Statistics of Income, are shown in Table II.[3]

The data in Table I are presented in graphic form in the following charts. In all the charts there will be noted a substantial degree of conformity in the movements of the ratios of both series in the period from 1918 to 1938, the latest year for which complete federal statistics have been issued. In certain of these groups the conformity is so close that

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City Bank Letter a table is given showing profits of leading manufacturing corporations for 1939 and 1940, "after depreciation, interest, taxes and other charges and reserves" and the percentage return on "net worth" for January 1 of each year. The 1939 figure for "total manufacturing" is 8.4 per cent, while the net to gross for representative corporations in "total manufacturing" given in Table I is 8 per cent for the same year. The closeness of these figures is of course partly coincidental. The "per cent return" given in the National City Bank Letter steps up to 10.5 per cent in 1940, while the net to gross percentage falls slightly, "net worth" not having risen in the interval as fast as gross earnings.

[3] Obviously, the term "representative" applies less to certain groups than to others. In "stone, clay and glass," for instance, there are but three companies in the "representative" category from 1918 to 1938 and consequently the correspondence of their ratio movements to those of the inclusive government group is less satisfactory.

In utilizing the categories of corporations given in Statistics of Income, the author has discarded the following: "agriculture and related industries" (as corporate activity is not typical of agriculture); "finance" (because of wide diversity of non-comparable activities, such as banking, insurance, real estate, stock-broking, and holding company, included therein); "transportation and other public utilities;" "construction;" "forest products;" and "service-professional, amusements, hotels, etc." His figure for "all corporations"—both for representative companies and corporate activity as a whole, as reflected in Statistics of Income—is made up, therefore, of all the categories except those omitted as above mentioned.

TABLE II

AVERAGE NUMBER OF CORPORATIONS FOR WHICH INDIVIDUAL RETURNS WERE ANALYZED AND AVERAGE GROSS INCOME AS A PERCENTAGE OF THE GROSS INCOME OF ALL CORPORATIONS IN THE GROUP REPRESENTED

Industry group	1918–38 Average number	1918–38 Average percentage gross income to gross for all corporations of group	1939 Number representative corporations	1940 Number corporations in sample
Total	187	11.2	185	103
Mining and petroleum	40	46.1	31	13
Total manufacturing	119	12.5	122	78
Food products, beverages and tobacco	26	8.2	27	18
Textiles and their products	13	2.7	13	9
Leather and its manufactures	5	14.6	6	4
Rubber products	8	60.8	7	7
Paper, pulp and products	6	3.4	9	6
Printing, publishing and allied industries	5	3.7	9	3
Chemicals and allied products	10	2.1	9	6
Stone, clay and glass products	3	4.2	4	4
Metals and their products	43	25.2	38	21
Trade	28	5.0	32	12

the ratios of net profit to gross income for all corporations may be forecast with a reasonable degree of assurance by bringing up to date the ratios for individual representative corporations in the same categories.

A word of caution should be inserted here. Any showing of the percentages of corporate gross income which trickle through into net gives us no direct cue to the national distribution of income. Thus there is no discrepancy between the Department of Commerce figures of national income distributed[4] and the series here given, despite the fact that the former show some 12.7 per cent going to capital in the form of interest and dividends in 1938, while the latter indicate that in the same year only 2.2 per cent of gross was converted into net. For here we are con-

[4] In the ten-year period from 1929 to 1938 an annual average of 15.6 per cent of the total national "income paid out" went to capital as dividends and interest. The average annual percentage of net profit on all capital employed to gross income for the same period, for the categories of corporations here dealt with, was 2.33 per cent, after deduction of minus quantities in 1931 and 1932. For the representative companies in the same groups, the annual average was 5.09 per cent.

The percentages are of course not comparable:—(1) National income paid out in many years is greater than national income produced (1930–35 and 1938), and in the period in question (1929–38) nearly 25 billions more were paid out than produced by the Nation's enterprise. This is a reflection of the huge governmental deficits, and the impairment of corporate assets in the years of deepest depression; (2) Corporate gross income is of course entirely different from the net figures of national income produced or distributed; (3) Net profits on total capital employed usually exceed interest and dividends; and (4) The corporate groups analyzed are not inclusive of all corporations (footnote 3), much less of all American enterprise.

cerned with the experience and prospects of "going business" units rather than with the distributive shares of the different factors of production in the Nation's aggregate income.

The payments made by any business for its raw materials, plant and equipment, and other outlays help to make up the gross incomes of other businesses, from which stem earnings on capital employed. Consequently any ratios of net to gross which are built up by aggregating the experiences of many different enterprises must necessarily be less than capital's share of the national income ("produced" or "distributed"), business outlays and receipts in such compilations being gross rather than net items. In other words, it is the nervous system of acquisitive business—profit margins, past, present and prospective—which make up our subject matter. The significance of such margins to the economy as a whole lies in the effects upon employment of labor and general business activity exerted by profits and the fluctuations attributable to changing prospects for such profits.

It should also be borne in mind that these percentages of net to gross built up from aggregate figures of the corporations in each group, include deficits incurred by many companies. Thus in 1938 returns filed by nearly 500,000 active corporations revealed that almost two-thirds of them incurred deficits. What we have here, therefore, is an over-all performance of certain corporate groups as reported to the Bureau of Internal Revenue. The representative corporations, being generally among the leaders in each category, make a better showing.

The following observations now suggest themselves from an examination of the charts and tables:

(1) Corporations as a whole showed a surprising degree of regularity (Chart I) in the proportions of their gross income available as net earnings on total capital employed, including borrowed capital, in the years 1922–29, during which period such ratio of gross available for net profit kept within $4\frac{1}{2}$ to $5\frac{3}{8}$ per cent, and averaged about 5 per cent. It is significant that in 1928 and 1929 this percentage was only a fraction of one per cent higher than in 1922, and was almost the same as in 1923, 1925, and 1926, a slight drop being registered in 1924 and 1927.

The representative series for all corporations has shown the same broad variations from year to year, but these companies—being in general the larger and more successful units[5]—register a higher percentage

[5] William L. Crum in his *Corporate Size and Earning Power* (Harvard University Press, 1939) defines profit as the amount available for equity earnings after taxes. This differs from "net profit" as here used by excluding interest paid for use of borrowed capital. It is of interest to note Professor Crum's conclusion that on the average large corporations are more profitable than small ones. However, this tendency for rate of earnings on shares to advance with size is shown to be true only when corporations reporting deficits are included with those operating in the black, and executive compensation is taken as cost rather than profit-share. These assumptions hold good in the present article.

of gross available as net earnings, with a gradual upward trend discernible between 1922 and 1929, interrupted in 1924 and 1927. The percentage was 8.4 in 1922, 10.5 in 1928, and a little over 11 in 1929. While an increase in the percentage is shown from 1927 to 1929, it is by no means as great as might have been expected, in view of the mounting gross earnings in the latter years of the "New Era" prosperity.

Both series dropped sharply from 1929 to 1932 during which years, for the first time in the entire post-war period, the Nation's corporations in these categories were earning less than nothing. Corporations in the representative series registered a marked upturn from 1932 to 1936–37 in their ability to convert gross into net, while federal statistics show the same trend. These two years brought corporate earning efficiency, measured in percentage of net to gross, to the general levels of 1924—though at no time since 1929 have earnings ratios recovered the levels and the stability of the 1922–29 period. When the inclusive data for 1939 are available a year hence, it will probably be shown that all corporations move with the representative ones in registering a rise in 1939 to about the percentages of 1935, after the slight decline in 1937 and the larger one in 1938.

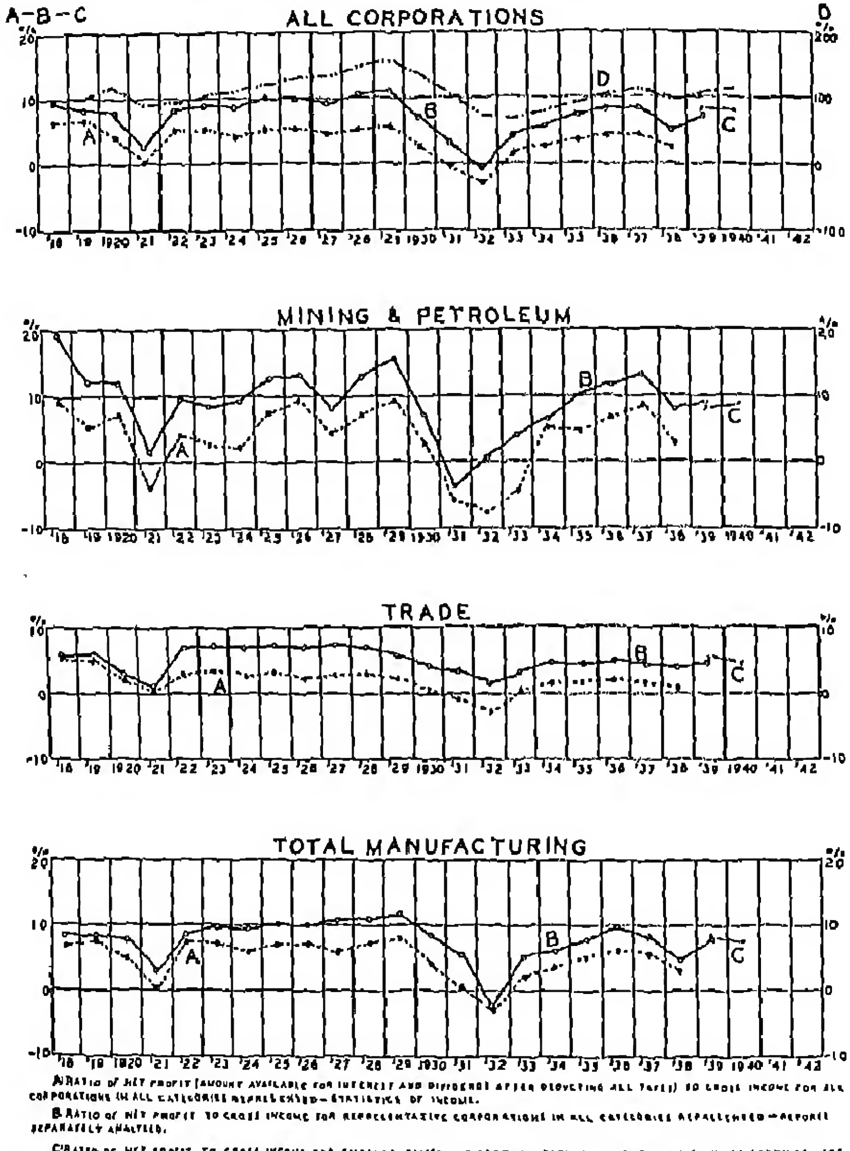
When this went to press the gross and net earnings of a number of representative corporations were available for 1940 (see Tables I and II). From this sample we gain a definite impression that ability to convert gross into net fell somewhat last year, the first full year of the second World War. The similarity of trend for the two series during the twenty-one years 1918–38 in which performance of the representative corporations may be compared with that of all corporations in the categories cited, gives us reason to expect that the federal figures for 1940 will show a similar slight impairment of earning power ratios.

(2) A chief reason, of course, is the heavy incidence of rising corporate taxation. The year 1940 witnessed increases in the basic federal corporate income tax rate from 18 to 24 per cent, and the imposition of an excess profits tax. The prospects of even heavier imposts and the uncertainties of war and of war-time controls make any restoration of the comparative earnings stability of the "twenties" improbable for some time to come.

(3) The dependence of corporate earning capacity upon volume of business is graphically depicted in the charts. Not only does gross income increase in years of prosperity but there is also a tendency, often marked, for the percentage of this gross income coming through into net profit to rise. The opposite is true in the "years of the locust." The accentuated effect upon common stockholders of these wide swings in over-all earning capacity hardly requires comment these days.

CHART I

RATIOS OF NET PROFIT TO GROSS INCOME



A RATIO OF NET PROFIT (AMOUNT AVAILABLE FOR INTEREST AND DIVIDENDS AFTER DEDUCTING ALL TAXES) TO GROSS INCOME FOR ALL CORPORATIONS IN ALL CATEGORIES REPRESENTED—STATISTICS OF INCOME.

B RATIO OF NET PROFIT TO GROSS INCOME FOR REPRESENTATIVE CORPORATIONS IN ALL CATEGORIES REPRESENTED—REPORTS SEPARATELY ANALYZED.

C RATIO OF NET PROFIT TO GROSS INCOME FOR SMALLER SAMPLE OF REPRESENTATIVE CORPORATIONS WHOSE EARNINGS WERE AVAILABLE (THROUGH 1939) WHEN ABOVE DATA WENT TO PRESS. SEE TABLE IX

D MOVEMENT OF BANK DEBITS FOR CITIES OUTSIDE NEW YORK (INDEX 1926=100)

This rough relationship between ratios of net profit to gross income and aggregate volume of business expressed in dollar amounts is visualized in the broadly similar movements of bank debits for cities outside New York (line D at the top of Chart I) and the earnings ratios for all corporations and for representative corporations. Variations of bank debits from a 1919 base are here taken as an approximate gauge of the trend of gross corporate receipts.[6] In every year since 1920 upward and downward movements of these bank debit and profit ratios series have synchronized except in 1924, 1926–27, 1937 and 1940, when the former moved up and the latter down, and in 1933, when the reverse was true.

(4) The much greater severity of the second post-war depression than of the first is graphically shown in substantial recovery of earlier earning power in the one year from 1921 to 1922 as contrasted with the recuperative period of four years from 1932 to 1936, a recuperation not completed when the setback of 1937–38 intervened.

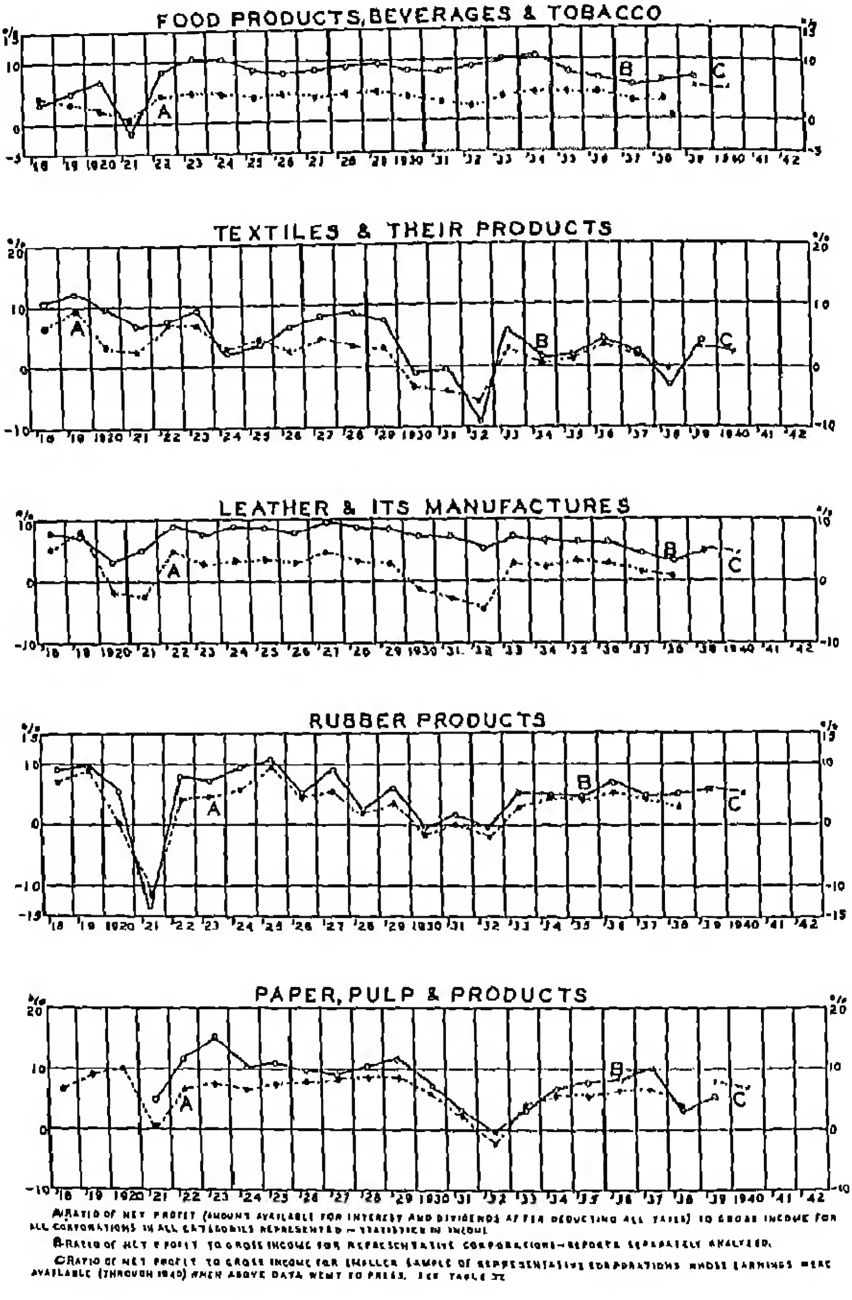
(5) Ratios of net profit to gross income from 1922 to 1929 showed a high degree of consistency in Total Manufacturing (Chart I) and here as well, the two lines move practically simultaneously, exceptions being in 1923 and 1927. For all corporations the ratio was less than 1 per cent higher in 1929 than in 1922, the average for this period being about 7 per cent, with decreases in 1924 and 1927. Again it may be remarked that the increase in ratio from 1927 to 1929 is by no means as great as might have been expected in the boom preceding the 1930–35 depression, and serves to point out the lesser degree of efficiency than is commonly supposed to have characterized industry in those years. The plunge from 1929 became even more precipitate from 1931 to 1932 (for representative corporations); and in the latter year the two series were close together in the No Man's Land of algebraic negatives. The recovery in 1933 was sharp for both series and continued through 1936, though by 1938 the net to gross had declined in representative companies to near the 1931 and 1933 levels, and in all companies to the vicinity of the 1934 level.

(6) Among the other groups given in the table the greatest degree of stability from year to year is to be found in Trade, and in Food Products, Beverages and Tobacco (Charts I and II). In the latter the percentage for all companies was practically the same in 1938 as in 1919, and a horizontal line can be drawn through most of the points from 1922 to 1933; while for representative corporations in the same group the 1939 percentage was not far from that of 1920.

[6] In the author's article on "Corporate Earnings" in this JOURNAL, March, 1934 (p. 47) it is pointed out that bank debits for cities outside New York have a close relationship to corporate gross earnings, the latter approximating one-half of the former over a considerable period of years.

CHART 11

RATIOS OF NET PROFIT TO GROSS INCOME



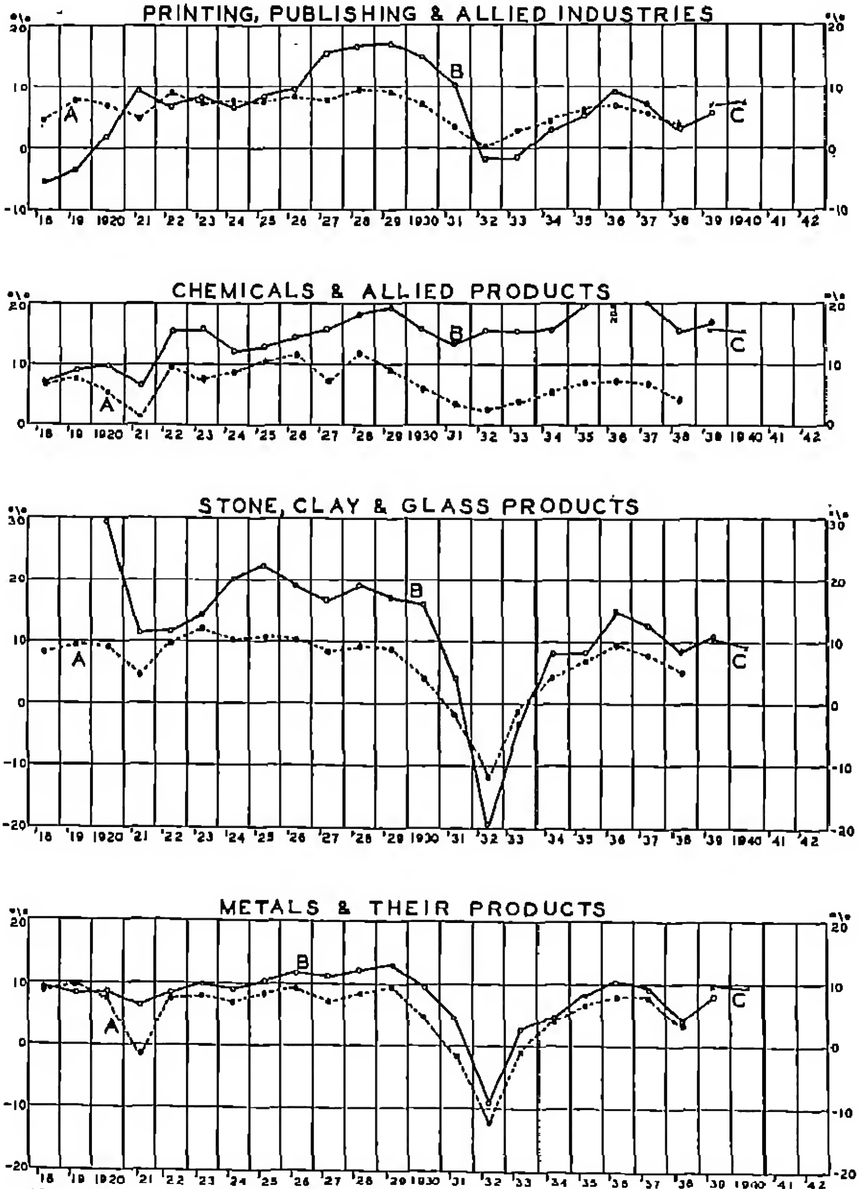
A RATIO OF NET PROFIT (AMOUNT AVAILABLE FOR INTEREST AND DIVIDENDS AFTER DEDUCTING ALL TAXES) TO GROSS INCOME FOR ALL CORPORATIONS IN ALL CATEGORIES REPRESENTED — STATISTICS OF INCOME.

B RATIO OF NET PROFIT TO GROSS INCOME FOR REPRESENTATIVE CORPORATIONS—REPORTS SEPARATELY ANALYZED.

C RATIO OF NET PROFIT TO GROSS INCOME FOR SMALLER SAMPLE OF REPRESENTATIVE CORPORATIONS WHOSE EARNINGS WERE AVAILABLE (THROUGH 1940) WHEN ABOVE DATA WENT TO PRESS. SEE TABLE IX

CHART III

RATIOS OF NET PROFIT TO GROSS INCOME



A Ratio of net profit (amount available for interest and dividends after deducting all taxes) to gross income for all corporations in all categories represented — Statistics of Income.

B Ratio of net profit to gross income for representative corporations — reports separately analyzed.

C Ratio of net profit to gross income for smaller sample of representative corporations whose earnings were available (through 1940) when above data went to press. See Table II.

Corporations engaged in Trade suffered an elimination of their earning power in 1931 and 1932, but by 1933 had reached the black again. Representative companies in this group, however, showed earnings through the depression's depths, and seem to have reached by 1934 a fairly stable ratio of earning power lower than obtained from 1922 to 1929.

Companies in the Food Products, Beverages and Tobacco group were comparatively little affected by the depression in their ratios of net profit to gross income. The charts show why shares in companies of this category are sometimes known as "resistance stocks."

(7) The other groups show wider variations from year to year, though the two series move along pretty well together. Until the world political situation is clarified and something like stable conditions return, it will be impossible to establish any long-term upward or downward trends, but there is nothing which gives promise of a restoration of the earning capacity of the decade of the twenties.

(8) Apart from whatever light may be thrown by research of this kind upon business movements in general, it is also of practical use in studying the performance of individual companies against the background of group experience. Any such application of this method, however, easily leads to unwarranted conclusions unless the characteristics and peculiarities of each company are taken into consideration and the groupings are essentially homogeneous in character. The varying methods of charging depreciation, and the exigencies of inventory profit and loss will also call for exercise of critical judgment.

SOURCES AND USES OF CORPORATION FUNDS*

By Arthur B. Hersey[1]
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This paper outlines a method of analyzing a series of year-end corporation balance sheets in such a way that changes in all asset and liability items are viewed in relationship to each other. Such an analysis is particularly helpful in illuminating the effective causes of changes in cash holdings and indebtedness of the corporations studied.

Increases in assets may be said to involve *uses of funds* by a corporation; increases in surplus or liabilities reflect and identify *sources of funds*. Thus, capital expenditures and the accumulation of inventories may be said to be uses of funds; among sources of funds are current earnings, short-term borrowing, security issues, and also drafts on cash, for the decrease of an asset may be regarded as a source of funds for expenditure.

The use of the term "funds" does not imply an attempt to reduce corporation accounts to a "cash-flow" basis. As used here, "funds" is merely a logical construct: "that which is debited and credited." Starting with the balance sheets for terminal dates and the income statements that constitute the final product of the accountants' work, the analyst works back to a balancing set of net credits and net debits for the year, each item of which is to have some economic significance. In this process he eliminates some inter-account ("non-cash") credits and debits made by the accountants. He may combine accounts, or shift them—with signs reversed—from one side of the balance to the other. It might be possible to trace the component parts of an adjusted "net source of funds" item back to their origins as credits paired with debits to cash, with debits to accounts receivable, or with debits to other accounts,[2] but in the balanced statement for a given period these distinctions are obliterated. A net "source of funds" in any one category merely implies that all other categories show a combined net "use of funds," in the sense indicated, of equal magnitude.

The adjustments made on the year-to-year changes in balance sheet

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[1] The writer has had the stimulating assistance of George P. Hitchings and Edward Boorstein.

[2] For example, a source of funds (not subject to adjustment) from stock issuance in a merger might have originated with a debit to fixed assets for property acquired. Again, a source of funds from inventory liquidation may be traced back to the excess of debits to cost of goods sold (for inventory passing into sales) over credits to cash, accounts payable, depreciation reserve, etc. (for materials, labor, and other costs charged to inventory). Debits to cost of goods sold are strictly non-cash entries, determined perhaps by past charges to inventory, but not by any current cash or receivables transactions with outside persons.

items are determined solely by considerations of usefulness for analysis. For example, a decline in capital stock that resulted from restatement of par value is to be adjusted, for obvious reasons; the apparent negative source of funds in this account is to be cancelled off against the apparent source of funds in surplus. Similarly, all declines in net fixed property account that resulted from debits to surplus or to profit and loss (writedowns and depreciation charges) are to be adjusted, so that the computed net use of funds for fixed assets ("capital expenditures") will be on a gross basis.[3] This procedure rests on a judgment that gross outlays for plant and equipment are a better datum for economic analysis than unadjusted changes in net property account. So-called "consumption" of fixed property, as measured by the accountants' straight-line original-cost depreciation, is not closely related to real losses of productive power through wear and tear and obsolescence. These are but two examples of numerous judgments that must be made in developing any set of source and use of funds items.

Charts I–VI relate to combined sources and uses of funds of 58 large companies in six industries: steel, petroleum, automobiles, machinery, rubber, and tobacco. This group of companies constitutes about one-fifth of all manufacturing and mining,[4] but is heavily weighted with producers' goods manufacturers. The financial statements used are those published in *Moody's Manuals*, which in many cases give a great part of the information available in statements filed with the SEC.[5] The computations made are subject to continuing revision. The period covered is the ten years 1930–1939.[6]

The reader should be cautioned that combined figures for a group of companies may not always reflect the actual behavior of individual companies. For example, in a sample of two companies one might have drawn down cash to increase inventories while another reduced inventories and retired debt; the inventory changes might wash out in combination, leaving a reduction in cash against a retirement of debt in the sample as a whole though neither company had drawn down cash to pay debts. Conclusions must be checked against components of the sample.

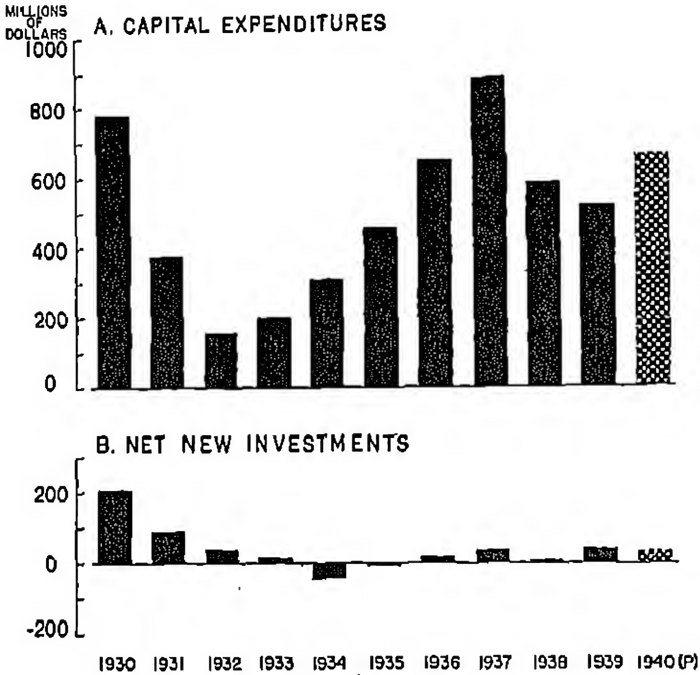
[3] Gross with respect to depreciation, etc., though not with respect to sums realized upon scrappage or disposal.

[4] At the end of 1933 total assets of the 58 corporations were $11,207,000,000, their inventories $1,790,000,000 and their cash and marketable securities $1,245,000,000. At the end of 1937 the corresponding figures were respectively $12,413,000,000, $2,803,000,000 and $917,000,000.

[5] Even with this information, it has not always been possible to make all adjustments theoretically called for. Some adjustments have been estimated. Few adjustments of less than $100,000 have been made, even where the data permitted.

[6] Preliminary figures for 1940 are also shown in the charts.

CHART I
USES OF FUNDS



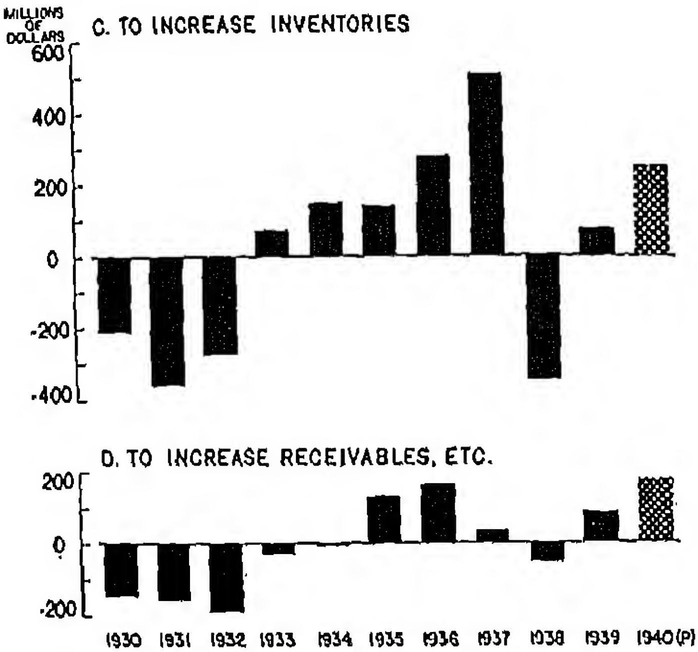
(a) The largest category of use of funds, on an annual basis, is usually "*capital expenditures*" (Chart I). This series represents expenditures for land, plant and equipment, less sums realized upon scrappage or disposal.[7] The figures show a characteristic business cycle pattern similar to that of net earnings (the total bars in Chart III), though with some tendency to lag in early phases of recession or recovery.

(b) "*Net new investments*" refers mainly to net new investments in securities of affiliates, whether carried on the balance sheet as investments or distributed among other accounts through consolidation.[8] The economic significance of this category is not clear-cut; in some respects it may be assimilated to capital expenditures, in other respects it is a negative of long-term finance.

[7] Computed by taking changes in net property account and adjusting (1) upwards for depreciation, depletion and amortization charges credited to gross property or depreciation reserves (adding also, for some companies, charges for actual outlays—as for oil-field development—which other companies capitalize and amortize), (2) upwards for writedowns or losses charged to surplus, and (3) downwards or upwards for changes resulting from mergers and consolidations and from reclassifications of assets.

[8] Computed as the change in accounts representing non-current investments, adjusted upwards for amounts paid (in cash or stock) in acquisition of new subsidiaries consolidated, and for writedowns.

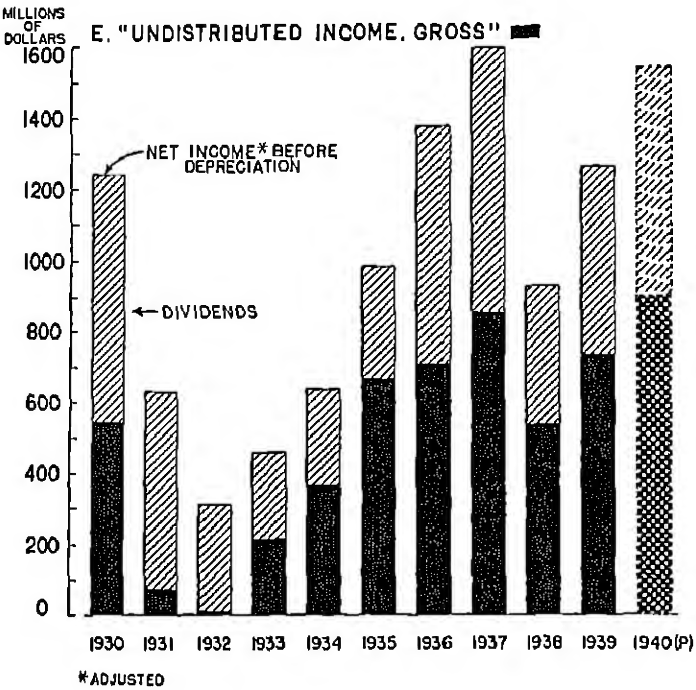
CHART II
USES OF FUNDS



(c) Funds used "*to increase inventories*" (Chart II) are often of major importance in short periods. Even on an annual basis the variations are sometimes much larger than those of capital expenditures. Unlike capital expenditures, these figures are negative in some years. The figures correspond to yearly changes in book value of inventory as computed by the companies' accountants.[9] Since usual methods of inventory accounting allow the whole inventory to increase in value when costs rise, and *vice versa*, this series does not necessarily represent changes in physical inventories. The figures as charted show a great volume of funds realized from inventory liquidation in 1930–1932 and in 1938. Especially in the earlier period, this represented only in part the liquidation of physical inventories. Other methods of accounting, by imputing less decline in value to the inventories on hand, might have shown part of these funds as coming from current net earnings.

[9] Minor adjustments are made for year-end writedowns where the data allow. In cases where the writedown is presumed to have affected net income and inventory change in the following year, adjustments are made on those quantities as well. The results correspond to what would be found if the companies followed their usual inventory accounting procedures consistently but without making writedowns. Adjustments are occasionally made in connection with consolidations.

CHART III
SOURCE OF FUNDS



(d) A fourth use of funds, *"to increase receivables, etc."* (Chart II), represents the year's change in book value of receivables and miscellaneous current assets.[10] From 1934 on, the cyclical movements in this series—so far as they are observable from yearly figures—seem to lead the movements of inventory changes by some fraction of a year.

(e) Turning to the flows of funds classified as sources, the largest on the average is *"undistributed income, gross"* (Chart III, solid bars). This is a single summary figure for current earnings less costs, expenses, and cash dividends.[11] It differs in one important respect from the ordinary accounting figure of net income less cash dividends paid.[12] Because we disregarded capital consumption in taking as a use of funds

[10] No adjustment is made for bad debt writedowns. All additions to receivables are non-cash transactions; a writedown merely indicates, *post facto*, that such additions had previously been excessive. (See footnote 16.)

[11] In a detailed analysis the payment of dividends might be treated as a separate use of funds. Total sales might even be given as a source item; costs and expenses deducted in arriving at net income would then be given as one or more use items.

[12] Other minor differences result from adjustments for writedowns, capital gains or losses, etc., in connection with counteradjustments on certain asset and liability accounts.

not the expansion of net depreciated property but the actual expenditures on plant and equipment, we now disregard charges against income for capital consumption and take net income before the accountants' deduction of depreciation, as a source of funds.

Since dividend payments are more stable than net income and changes in dividends lag behind changes in income, "undistributed income, gross" generally alters more rapidly during the early phases of recession or recovery than does net income (before depreciation). The undistributed profits tax imposed in 1936 and virtually removed in 1938 influenced the timing of dividend payments and largely explains the very small gain in undistributed income in 1936 as well as the moderate size of the drop in 1938, a recession year in which dividends were sharply reduced contrary to usual expectations.

(f) Another source item, funds obtained *"through increase in accounts payable and accrued liabilities, etc."* (Chart IV), represents the year's increase in such current liability accounts as trade payables, accrued or reserved-for taxes, interest and payrolls, and dividends payable. The yearly figures have a cyclical pattern of change, from 1934 on, very much like that of "funds used to increase receivables" (Chart II).

(g) Three of the source-of-funds categories may be called "financial sources." Two of these, shown in Chart IV, may also be called "external sources." The first of these is "funds obtained through short-term borrowing."[13] Except in 1937 and 1938, these 58 corporations apparently accounted for a rather small part of the important changes during this ten-year period in banks' short-term commercial loans and open-market commercial paper.

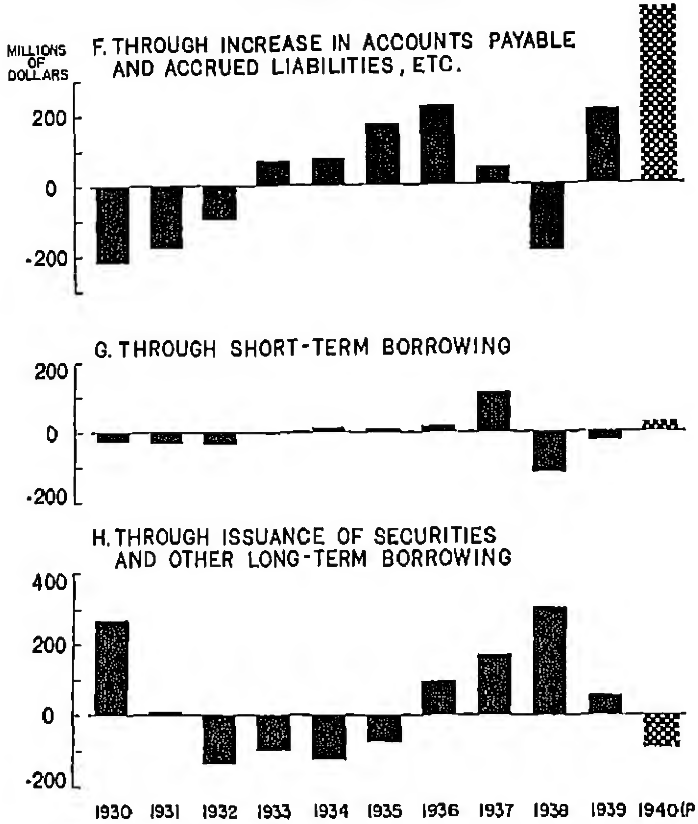
(h) The second "external" source of funds, *"through issuance of securities and other long-term borrowing"* (Chart IV), includes common and preferred stocks, bonds, and term loans.[14] This series shows a rather different cyclical pattern than the other series in Charts I–IV. First, unlike those series that relate to current assets and liabilities, it has a fairly smooth broad sweep. Second, it tends to lag behind all the other series. However, the lag at 1937–1938 is perhaps exaggerated by the chart, for the 1938 figure includes a single $100,000,000 bond issue of

[13] Computed by taking yearly changes in notes payable shown as current liabilities, and adjusting to exclude long-term debt items placed among current liabilities as they approach maturity.

[14] Issues in exchange for assets or as bonuses are included but stock dividends are excluded. All redemptions and repurchases are taken as deductions (whether or not securities repurchased were retired) by using such asset accounts as treasury stock in the computation. The figures are put on a value-received rather than par value basis, so far as the data permit; i.e., adjustments are made against surplus and unamortized debt discount to reflect premiums, discounts and expense of issuance, and restatement of common stock value. If cash has been earmarked for security redemption, redemption is regarded as taking place at that time.

CHART IV

SOURCES OF FUNDS

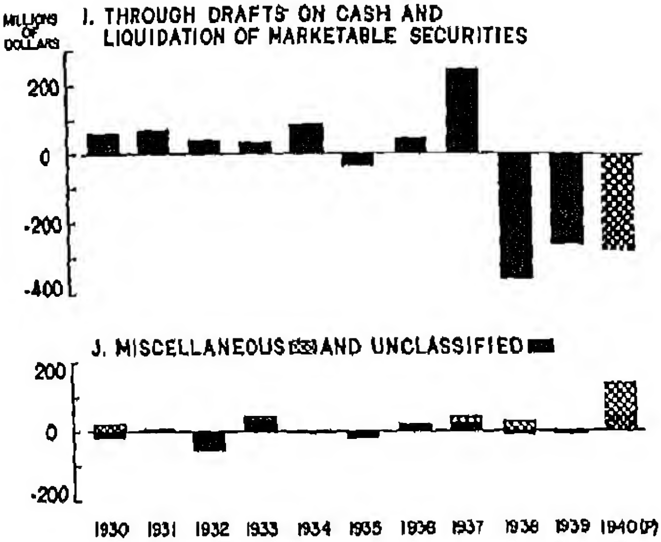


U. S. Steel which under slightly different circumstances might have been offered in 1937. It is noteworthy that sums used to retire indebtedness and preferred stocks over the years 1932 to 1935 were about two-thirds as great as the net amount obtained from security issuance and other long-term borrowing in the following four years.

(i) The third "financial" source of funds is *"through drafts on cash and liquidation of marketable securities"* (Chart V).[15] A positive figure here means a decline in an asset. The data for individual companies show more scatter in the size and direction of yearly changes in cash and equivalent than in practically any of the other source or use of funds categories, but a definite pattern emerges when a sizable sample is built up. The 58 companies combined reduced their cash and equiva-

[15] Cash and marketable securities have been combined in the chart for simplicity's sake; there has been some tendency since 1934 for these companies to shift from marketable securities to cash.

CHART V
SOURCES OF FUNDS

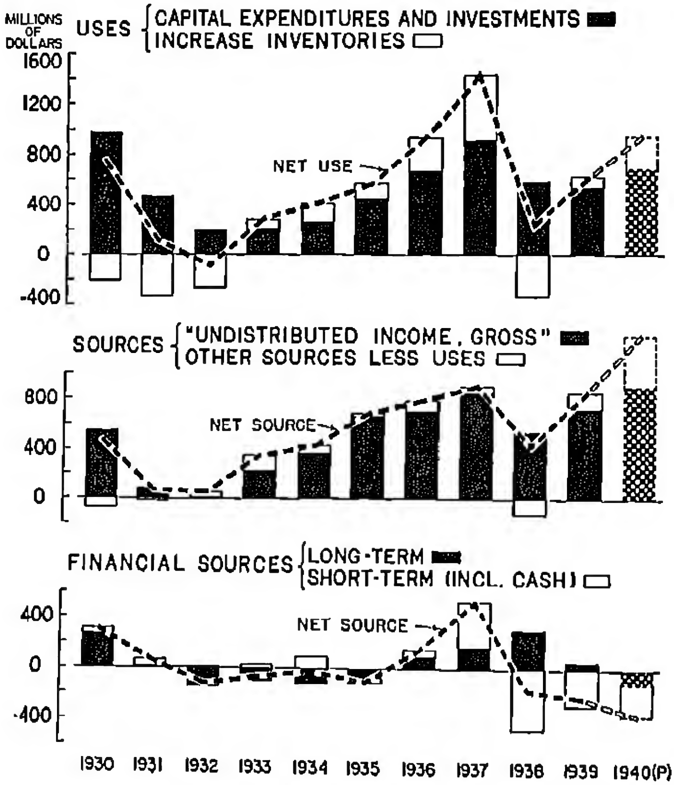


lent in every year but one up to 1937. It is clear that the economic problem of "idle cash" is not a problem of cash in the hands of large manufacturing companies. However, drafts on cash were relatively small until 1937; in no year before 1937 did the net total change in cash and equivalent on hand exceed 7 per cent. Over the whole period from end of 1929 to end of 1939 there was a net increase of about $90,000,000, or 6 per cent.

(j) Finally, there are "*miscellaneous*" and "*unclassified*" sources of funds (Chart V). The "miscellaneous" sources include a few large special receipts such as refunds of taxes paid in earlier years and advance payments on certain long-term contracts. The reasons for an "unclassified" category are (1) lack of sufficient footnote information in the financial statements used, and (2) the desire to keep the other categories as clear-cut as possible and to avoid setting up a number of small miscellaneous categories.[15]

[15] The unclassified class mainly reflects certain changes in contingency reserves and surplus and in miscellaneous non-current assets and liabilities. Increases and decreases in contingency reserves in certain cases might be allocated respectively as additional net income and as upward adjustments on changes in asset accounts written down to reserves. There are objections to this procedure, partly arising from lack of data. For example, it is undesirable to adjust the change in receivables, say, upward in one year unless counteradjustments downward can be made in preceding years when the sales were made which later proved uncollectible; otherwise an unreal upward bias would be given to the cumulated net change in receivables. (A net effect of such upward and downward adjustments on receivables would probably be to reduce the apparent amount of liquidation for 1932 shown in Chart II.)

CHART VI
SUMMARY



The series reviewed raise interesting questions of classification and definition. They are also interesting as sample indexes, even though they may be unrepresentative of larger aggregates. But their chief interest lies in the composite picture they yield, an objective bird's-eye view of the process of corporation financing at work. In Chart VI an attempt is made to summarize this composite picture.

The upper part of the chart shows the net total of funds used each year for capital expenditures, new investments, and inventories. The second part shows the net total of funds obtained from accrued income, from changes in accounts payable less accounts receivable, and from miscellaneous and unclassified sources. This roughly approaches a "cash-basis" total of funds from current operations. The bottom part shows the net total of funds obtained from "financial" sources.

The financial operations of these 58 corporations during the years 1930–1939 seem to exemplify three principles.

First, *that net issuance of securities and other long-term borrowing bears no simple relationship—either as to amount or timing—to capital expenditures and net new investments.* Observe the increase in capital expenditures from 1933 to 1935 and the steady rate of net liquidation of long-term finance in those years, and the rise and fall of capital expenditures from 1936 to 1938 and the steady increase in new long-term financing in those years. In all of these years current earnings provided much of the funds needed for capital expenditures. The need to draw on financial sources developed in proportion not to capital expenditures themselves, but to the excess of capital expenditures and inventory expansion combined over funds retained from earnings. And long-term borrowing was only one of the available financial sources. So far as large manufacturing corporations during this period were concerned, the notion that new capital issues supplied an index to fixed asset expansion had no validity. The term "issues for new capital" should be used to refer to "capital" only on the *liability* side of the balance sheet.

Second, *that short-term financing with notes payable or by drawing down cash or equivalent tends to act as a cushion* to absorb for a while an increase in funds needed for fixed or working asset expansion or renewal which cannot be met from currently retained cash receipts from operations. The short-term financing of these companies in 1936 and 1937 is a striking example; a number of these companies also did more short-term financing with cash and equivalent in 1934 than in adjacent years, 1934 being a year when their requirements met from financial sources were greater than in adjacent years. But after a period of heavy short-term financing, a reaction tends to set in. Observe the liquidation of short-term finance in 1938 and 1939, and also in 1935.

Third, *that long-term financing comes into play only as needs for funds persist or expand beyond the capacity of short-term financing to provide for them, or else as corporations find it desirable and possible to finance at long-term in order to strengthen their short-term position.* But with long-term financing, too, there are incentives to liquidate debts when funds are available for the purpose. Observe the liquidation of long-term finance in 1932–1935.

Conclusions from the sample data for this period do not seem to be accidental; data for subgroups of this sample also show these statistical tendencies at work, of course with due exceptions.[17] How far these generalizations may be applicable to the financing of companies of lessor financial standing than these or of companies in other fields of business remains an open question.

[17] During a period of substantial price or tax increases, corporations may experience a continuous pressure to increase their cash balances. This would require some modification of the "impact-cushioning" view of changes in cash holdings developed in this paper.

THE VALIDITY AND SIGNIFICANCE OF MALE NET REPRODUCTION RATES

By Robert J. Myers, *Social Security Board*

Analyses of reproductivity commonly utilize the female net reproduction rate (or else the "intrinsic rate of increase" determined therefrom). There is calculated the number of daughters that will be born to 100 females who start life together and are subject to specified fertility and mortality rates. Instead of relating daughters to females, there might just as readily be computed the sons that will be born to 100 males.[1] Although at first glance it would seem as though rates for men are without meaning since women actually bear the babies, it should be remembered that where there is a mother, there must also be a father. Of course, one man could be father to several babies in a given year, but on the other hand, one woman could give birth to twins or triplets. This paper will first examine the theoretical aspects of male versus female net reproduction rates and then analyze actual data for the United States.[2]

Digressing a bit, it may be pointed out that the usual definition of the net reproduction rate for women may be, and in practice usually is, modified somewhat in order to facilitate calculation. Instead of using age-specific birth rates based on female births as called for by the definition,[3] rates based on total male and female births may be used. The necessary adjustment is made by multiplying the sum of the products of the age-specific birth rates and female survival rates by the proportion of births that are female.[4] In actual practice such total age-specific birth rates are often available instead of the female age-specific birth rates required by the definition.

In a theoretical stationary population, although the age-specific birth rates for men (paternal frequency by age)[5] differ from those for women, the two net reproduction rates will always be the same. However, because of varying sex proportions at the reproductive ages, actual popu-

[1] This device was developed by Professor E. I. Gumbel (see Kuczynski, Robert R., *Fertility and Reproduction*, p. 30).

[2] Kuczynski on pp. 30–38 of *Fertility and Reproduction* calculates reproduction rates for both sexes for France and makes some analyses of the difference between the two rates. However, as far as the author knows, the theoretical aspects of this subject as well as its application to United States data have never been fully examined.

[3] For an illustration of the theoretical method of calculating net reproduction rates, see Dublin, Louis I., and Lotka, Alfred J., *Length of Life*, p. 245.

[4] This procedure is followed by Kuczynski (see footnote 2). For an analysis of the accuracy of this approximate method see Myers, Robert J., "Population, Birth, and Mortality Trends in the United States," *Transactions of the Actuarial Society of America*, Vol. XLI, May 1940, p. 101.

[5] I.e. ratio of births to fathers of a given age to total number of men of that age.

lations frequently give different values when separate calculations are made. If there is a temporary excess of females at the reproductive ages, age-specific birth rates and the net reproduction rate calculated for women will be relatively low as compared with those computed for men. For example, a calculation covering the experience in France during 1920–23 gave a net reproduction rate of 97.7 for women and 119.4 for men.[3] This large difference is readily explained by the smaller number of men in the reproductive ages as a result of the ravages of the First World War. It is not always possible to say whether in a given case men are over-represented or women under-represented in the population (or *vice versa*). Therefore, it seems that consideration might well be given to the possibility of using the male rate as well as the female for an index of the "intrinsic rate" of population growth.

One cause of differences between the male and female net reproduction rates as calculated for a given population is a lack of balance between the sexes at the reproductive ages. Two ways that this can occur (or appear to occur) are through immigration and through misstatement of age in census reporting. The following discussion will examine these two factors, using as a base a hypothetical stationary population resulting from 100,000 female births each year in the past.

Table I shows the effect of excess female immigration (namely, 10,000 aged 20 in each future year) on the calculated net reproduction rate based upon the assumption that this influx has no effect on the number of births. This is quite possible, since the total male population is not changed, so that the total number of marriages and births might conceivably remain as before. Prior to immigration, it has been assumed that the birth rate set down in column 3 would be in effect so that the number of births would be as in column 4. These rates were so selected as to result in a net reproduction rate of exactly 100.

After 30 years of immigration, the age distribution of the female population is as shown in column 5. The age-specific birth rates at this time are obtained by dividing the births of column 4 by the larger population of column 5 and result in a net reproduction rate of only 91.3. On the other hand, in such a population the net reproduction rate calculated for men would have remained at 100 throughout the entire period rather than decreasing steadily as did the female rate. If the excess female immigration were to cease and the number of births continue constant, the female net reproduction rate would gradually increase until after another 30 years it would again be 100. In this particular instance the male net reproduction rate seems to be the more reliable,

[3] See footnote 2.

TABLE I

EFFECT OF IMMIGRATION ON NET REPRODUCTION RATE OF STATIONARY POPULATION* WITH ASSUMED AGE-SPECIFIC BIRTH RATES†

Age group (1)	Prior to immigration		Number of births‡ (4)	After 30 years of immigration	
	Women (2)	Birth rate† (3)		Women (5)	Birth rate§ (6)
15–19	457,285	52	23,779	457,285	52.0
20–24	451,278	130	58,666	500,992	117.1
25–29	443,780	120	53,254	492,580	108.1
30–34	435,638	80	34,851	483,542	72.1
35–39	426,397	60	25,584	473,285	54.1
40–44	415,339	20	8,307	461,005	18.0
45–49	401,224	3	1,204	445,344	2.7

Net reproduction rate, prior to immigration¶ =100.0
Net reproduction rate, after 30 years of immigration** =91.3

* Based on U. S. White Females 1929–31 Table. It is assumed that there are 10,000 female immigrants each year in future (all at age 20).

† These rates are arbitrarily set down and apply prior to immigration.

‡ It is assumed that the number of births by age of mother are not changed by the female immigration.

§ 1000 times column 4 divided by column 5.

¶ Obtained by cumulative multiplication of columns 2 and 3, the result being then multiplied by .4864 (the proportion of girl births based on a sex ratio at birth of 105.6) and divided by 1,000,000.

** Obtained by cumulative multiplication of columns 2 and 6, the result being then multiplied by .4864 and divided by 1,000,000.

but of course it is recognized that excess male immigration would produce exactly the opposite result.

Similar to the effects of immigration, the ravages of war in depleting the ranks of the young men could have the effect of producing a relatively low female net reproduction rate and, correspondingly, a relatively high male rate. After conditions had had a chance to stabilize, it is quite likely that the two net reproduction rates would again approach more closely.

Table II deals with a stationary female population in which there are assumed to be certain arbitrary biases in the reporting of ages; however, it is hypothesized that there is accurate reporting of the ages of mothers in connection with the births. In accordance with United States population characteristics women over 30 are assumed to understate their ages (10 per cent of those in each quinquennial age group understating by 5 years and 5 per cent understating by 10 years with the other 85 per cent correct), while those under 20 are assumed to overstate (10 per cent overstating by 5 years), with those between 20 and 30 reporting correctly (or with counterbalancing errors). A set of assumed "true" birth rates has been selected to apply to the correct ages of women, namely the same as in Table I. The application of these

TABLE II

EFFECT OF BIAS IN REPORTING OF AGE* ON NET REPRODUCTION RATE OF STATIONARY POPULATION† WITH ASSUMED AGE-SPECIFIC BIRTH RATES‡

Age group (1)	Women in age group according to Life Table (2)	"True" birth rates‡ (3)	Number of births (4)	Women in age group for bias in reporting of age (5)	"Reported" birth rates§ (6)
10-14	460,973	-	-	. .	—
15-19	457,285	52	23,779	457,051	52.0
20-24	451,278	130	58,666	518,788	113.1
25-29	443,780	120	53,254	508,670	104.7
30-34	435,038	80	34,803	433,[illegible]	80.4
35-39	426,307	60	25,578	424,032	60.3
40-44	415,333	20	8,307	412,292	20.1
45-49	401,224	3	1,204	379,311	3.2
50-54	382,740	—	—	. .	—

Net reproduction rate, no bias¶ =100.0
Net reproduction rate, with bias** =93.2

* It is assumed that all bias exists in the female population and that there is none in the data dealing with ages of mothers for the births.

† Based on U. S. White Females 1929-31 Table.

‡ These rates are arbitrarily set down and are assumed for the purpose of this discussion to be theoretically "true" rates such as would be obtained if no bias in age reporting existed.

§ 1000 times column 4 divided by column 5.

¶ Obtained by cumulative multiplication of columns 2 and 3, the result being then multiplied by .4804 (the proportion of girl births based on a sex ratio at birth of 105.0) and divided by 1,000,000.

** Obtained by cumulative multiplication of columns 2 and 6, the result being then multiplied by .4804 and divided by 1,000,000.

rates to the "true" female population results in the births shown in column 4. Column 5 lists the population as it might presumably be reported by a census, while column 6 giving the "reported" birth rates results from dividing the total births by total reported women. These latter age-specific birth rates produce a net reproduction rate of only 93.2 so that the assumed bias in age reporting was responsible for a 7 per cent error.

Another cause of difference between the net reproduction rates for men and women is the immaturity of the population even though at each age there is a perfect balance between the sexes. The fact that fathers are, on the average, older than mothers tends to produce instability from a fertility standpoint. Thus, for example, in a growing population husbands of a given age are the survivors of relatively fewer births than their wives. The male population is thus relatively under-represented so that the male net reproduction rate will be higher than the female one. This may be seen in the specific example given in Table III. There the assumed population is based on an increasing percentage

reduction from the basic stationary population for each age group after age 20 for both men and women. The further arbitrary assumption is made that the births to women in a given quinquennial age group may be taken as applying to men 5 years older.[7] Again the age-specific birth rates for women are those of Table I. For this population the net reproduction rate for men is 106.0 as contrasted to 100.0 for women. Thus immaturity of population[8] may result in a sizable differential.

TABLE III

EFFECT OF IMMATURITY OF POPULATION ON NET REPRODUCTION RATE OF ASSUMED POPULATION*

Age group (1)	Stationary population†		Assumed population*		Assumed birth rate for women‡ (6)	Births to		Birth rate for men** (9)
	Women (2)	Men (3)	Women (4)	Men (5)		Women § (7)	Men ¶ (8)	
15–19	457,285	472,705	457,285	472,705	52	23,779	—	—
20–24	451,278	465,405	428,714	442,102	130	55,733	23,779	53.8
25–29	443,786	456,983	399,407	411,285	120	47,929	55,733	135.5
30–34	435,538	447,679	370,202	380,527	80	29,623	47,929	126.0
35–39	426,397	436,558	341,118	349,246	60	20,467	29,623	84.8
40–44	415,333	422,242	311,500	316,682	20	6,230	20,467	64.6
45–49	401,224	403,407	280,857	282,385	3	843	6,230	22.1
50–54	382,740	378,847	248,781	246,251	—	—	843	3.4

Net reproduction rate based on women†† = 100.0
Net reproduction rate based on men‡‡ = 106.0

* Assumed population is 100 per cent of stationary population (see footnote†) for ages 15–19, 95 per cent for ages 20–24, reducing by 5 per cent for each quinquennial age group to 65 per cent for ages 50–54.

† Based on U. S. White Males and Females 1929–31 Life Tables with 100,000 female and 105,000 male births annually.

‡ These rates are arbitrarily set down.

§ Column 4 times column 6 divided by 1000.

¶ It is arbitrarily assumed that the number of births to men in a given age group is the same as for women 5 years younger.

** 1000 times column 8 divided by column 5.

†† Obtained by cumulative multiplication of columns 2 and 6, the result then being multiplied by .4864 (the proportion of girl births based on a sex ratio at birth of 105.6) and divided by 1,000,000.

‡‡ Obtained by cumulative multiplication of columns 3 and 9, the result then being multiplied by .4864 and divided by 1,000,000. (The proportion of girl births is used since the male stationary population figures of column 3 are based on 105,000 births; the proportion of male births, .5136, divided by 1.056, equals .4864).

As the population matures in the above example, both the male and the female age-specific birth rates cannot remain constant; one or the other must change. The common usage of only the female net reproduc-

[7] In 1930 the average ages of mothers and fathers were 27.0 and 31.5 respectively, or a differential of 4.5 years (calculated from Table M, p. 8, *Birth, Stillbirth, and Infant Mortality Statistics*, 1930).

[8] Incidentally, it may be pointed out that none of the major countries has anywhere near a mature population, although some such as France and the Scandinavian countries more nearly approach this condition than do others such as the United States and Australia.

tion rate in assuming that the female age-specific birth rates will remain constant into the future makes the tacit assumption that the male rates will vary. There seems to be no more logic in such an assumption than in assuming that male rates remain constant with the female rates changing in accordance.

Next, turning our attention to actual figures for the United States, male and female net reproduction rates are presented in Table IV. It should be pointed out that since these figures are for all races combined, they may be open to criticism as pertaining to a non-homogeneous

TABLE IV

NET REPRODUCTION RATES FOR MEN AND WOMEN, ALL RACES COMBINED, 1920-35*

Calendar year	Unadjusted rates		Adjusted rates†		Ratio of male to female rate (per cent)
	Men	Women	Men	Women	
1920	121.8	117.4	131.5	126.8	103.7
1930	106.7	98.7	115.2	106.6	108.1
1935	97.1	89.0	104.9	96.1	109.2

* Based on age-specific birth rates calculated from census data, sex proportion at birth (from census reports), and the applicable U. S. Life Tables (1919-21 for the 1920 calculation, 1929-31 for 1930, and 1935 Metropolitan Table for 1935), with survival rates obtained by weighting white ones by 9 and colored ones by 1.

† Adjusted for under-reporting of births (assuming 92.6 per cent complete).

group. However, there is always the question of how far to sub-divide in order to obtain homogeneity. At any event these rates are crudely indicative of the reproductivity of the country as a whole. Moreover, these data are being used primarily to illustrate the differences resulting in reproduction rates as calculated separately for men and women.

From this table it may be seen that the male rate has always been appreciably higher than the female rate. In 1920 the relative difference was only 4 per cent, whereas for 1930 it was about 8 per cent and for 1935 almost 10 per cent. There has been considerable discussion in demographic literature over the fact that the adjusted net reproduction rate (as calculated for women) fell below 100 shortly after 1930. However, the rate for men is still safely above the replacement level, although it has declined rapidly since 1920. Perhaps the fear that the United States is not currently reproducing itself (based on the female net reproduction rate being below 100) is unfounded since the rate for men is well over 100.[9] It is impossible to say which rate is the true one; perhaps the correct answer lies somewhere between.

[9] Incidentally, the adjusted net reproduction rate for women increased after 1935, being 101.0 for 1938 compared with 96.1 for 1935. Male rates have not been obtained for years after 1935.

The difference between the net reproduction rate as calculated separately for men and women is explained by the variation in the relative proportions of men and women in the population as shown by Table V. The upper portion of the table indicates that at each age between 15 and 35—by far the most important child-bearing period—there were about 2 per cent fewer males than females in both the 1920 and 1930 populations. However, according to the stationary population distribu-

TABLE V

SEX RATIOS* FOR PERSONS IN CHILD-BEARING AGES

Age of women	United States population 1920	United States population 1930	1929–31 White Life Table†
	Ratio for Men of Same Age‡		
10–14	101.8	102.2	103.0
15–19	98.3	99.4	103.4
20–24	95.3	99.4	103.2
25–29	99.8	97.7	103.0
30–34	104.8	100.1	102.8
35–39	110.1	103.3	102.4
40–44	107.4	107.3	101.7
45–49	117.8	108.9	100.5
50–54	115.3	110.1	99.0
	Ratio for Men 5 Years Older§		
10–14	88.7	97.0	102.5
15–19	95.2	92.1	101.8
20–24	95.5	87.8	101.3
25–29	99.8	91.7	100.9
30–34	103.4	102.7	100.2
35–39	88.8	91.3	99.0
40–44	101.9	95.8	97.1
45–49	95.8	92.0	94.4
50–54	85.5	85.3	90.5

* Males per 100 females.

† Based on stationary population supported by 100,000 births annually of which 48,940 are female (corresponding to a sex ratio at birth of 105.0).

‡ I.e., ratio of number of men in given quinquennial age group to number of women in same age group.

§ I.e., ratio of men in next older age group to women in given age group.

tion, there should be about 3 per cent more males because of the greater proportion of male births. This is all the more confusing when it is considered that in the past male immigration has exceeded female immigration. The relative over-representation of women at each age (or conversely the under-representation of men) amounts to about 5 per cent and is a partial cause of the difference between the two net reproduction rates.

The comparison of men and women of the same age in the upper portion of Table V indicates a lack of balance that might be caused by either immigration or misstatement of age. The data in the lower portion of the table in comparing men to women 5 years younger takes into account not only the above two factors but also the immaturity of the population. Thus, whereas for a stationary population the ratios up to age 35 should have shown about 1 per cent more males, actually they indicated as much as 10 per cent less. Therein probably lies the explanation of the differential between the two net reproduction rates. As may be noted for ages 15–34, the 1920 figures are, in general, closer to the stationary population figures than are the 1930 ones. This explains why the differential for the 1920 rates is smaller than that for the 1930 ones.

The three hypothetical cases considered previously throw some light on the difference between the male and female rates for the United States. On the one hand, past immigration being mostly male would tend to make the female rate higher, while on the other hand, deliberate understatement of age by women and the general immaturity of the population would tend to make the male rate higher. Undoubtedly, the effect of the latter two factors has more than offset that of the first. The counterbalancing effect of the immigration factor has been considerably negated in respect to the 1930 and 1935 figures because of the decreasing trend of immigration since 1920. This perhaps explains the increasing differential between the male and female rates.

It is difficult to say categorically whether the male or the female rate should be used in any particular case. Perhaps the most adequate method of analysis is to utilize the two rates as a range within which the "true" value must lie rather than merely using the female rate as is commonly done.

THE RELATION BETWEEN THE DESIGN OF AN EXPERIMENT AND THE ANALYSIS OF VARIANCE

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I do not propose to present any new designs or any new relations between the design of an experiment and the analysis of the results but rather to present some of these relations in a way that has helped me to gain a fuller understanding of various designs and the analysis of variance appropriate to them. In addition, I believe this method of presentation has enabled me to assist some of my students to gain a more complete understanding of these useful tools.

In the beginning of our study of the analysis of variance, if but one criterion of classification were involved, most of us were able to calculate separately the total sum of squares and the two partitions of it, that is, the sum of squares "between groups" and the sum of squares "within groups." As for the number of degrees of freedom corresponding to each sum of squares we learned a rule which might be called the rule of "one less." Thus, the total number of degrees of freedom was one less than the total number of observations and the number for "between groups" was one less than the number of groups. A bit more difficulty was met in applying this rule to the within group partition, since it had to be applied to the groups separately and the results summed, hence the more convenient scheme of subtracting the number of degrees of freedom for "between groups" from the total number came into rather common use. If the number of groups was at all large, this convenient scheme of subtracting was used to determine the "within group" sum of squares as well. As the experiments became more complex some of us calculated the total sum of squares and the several easily computed partitions of it and then, by subtraction, lumped what was left and frequently labeled it remainder.

Snedecor (6) in his little book *Calculation and Interpretation of Analysis of Variance and Covariance,* which has been out of print for some time, has done just this in example 3. In fact he says, "There is no practical way of verifying the foregoing computations save by repetition." Other means of calculation are, of course, now known. One which appeals to me as convenient and illuminating involves the evaluation of the individual degrees of freedom. These are variously known as partitions of rank one, quadratic forms of rank one, independent compari-

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

TABLE I

CALCULATION OF PARTITIONS OF TOTAL SUM OF SQUARES APPROPRIATE TO EACH DEGREE OF FREEDOM

		1913		1915		1917		1923		1929		Sums	Divisors	(Sum)² / divisor
		A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*			
		16.51	12.92	39.99	40.87	19.86	19.03	22.38	20.76	14.87	13.28			
Comparisons														
Variety	V	+	−	+	−	+	−	+	−	+	−	6.73	10	4.529
Year	Y_1	+	+	−	−							−51.43	4	661.261
	Y_2	+	+	+	+	−2	−2					32.51	12	88.075
	Y_3	+	+	+	+	+	+	−3	−3			19.82	24	16.368
	Y_4	+	+	+	+	+	+	+	+	−4	−4	79.70	40	158.802
Interaction	$V \times Y_1$	+	−	−	+							4.47	4	4.995
	$V \times Y_2$	+	−	+	−	−2	+2					1.05	12	.092
	$V \times Y_3$	+	−	+	−	+	−	−3	+3			−1.26	24	.066
	$V \times Y_4$	+	−	+	−	+	−	+	−	−4	+4	−1.22	40	.037
Check		+9	−	+5	−	+	−	−3	−	−7	−	90.37 90.37	170 170	

Summary of Analysis

Comparison	D/F	Sum of squares
Variety	1	4.529
Year	4	924.507
Variety × year	4	5.190
Total	9	934.226

sons, orthogonal comparisons, individual comparisons and individual degrees of freedom. Cochran (1), Snedecor (7), Fisher (3), Irwin (4), Yates (8), Craig (2), Madow (5), and others have discussed these forms. To illustrate, I shall use the yields in bushels per acre of two varieties of corn, A and B, grown on acre plots in five different years. The data, indicated computations, and results are given in Table I.

Each row in the table represents a function of the individual yields which serves as a guide in calculating the sums in the second from the last column. Each row except the last represents an independent comparison between these individual yields. The coefficients in the last row are secured by adding those in the columns immediately above and make up a function which provides a partial check on the accuracy of the second from last and next to last columns. The sum of the divisors must check with the sum of the squares of the coefficients in the last row. The sum of the sums must check with the algebraic sum of the individual yields indicated by the function in the check row. The divisors are the sums of the squares of the coefficients in the corresponding function. The sum for any row is the algebraic sum of the individual yields indicated by the function in that row. The total sum of squares in the summary must check with the total sum of squares calculated from the 10 yields as follows:

$$(16.51)^2+(12.92)^2+\cdots+(13.28)^2-(220.45)^2/10$$
$$=5794.0465-4859.8202=934.2263$$

In factorial experiments other partitions of the total sum of squares become important and it becomes necessary to isolate them. Yates (8) in *The Design and Analysis of Factorial Experiments* presented a factorial experiment on potatoes which involved two levels of nitrogen, two of potash, and two of barnyard manure or 8 treatment combinations in all. The field plan consisted of 4 replicates in randomized blocks. The structure of this experiment may be specified by the following subdivision of the total number of degrees of freedom:

TABLE II

Comparisons	D/F
Blocks	3
Treatments	7
Error (block × treatment)	21
Total	31

However, the factorial design makes it possible to isolate each of the 7 degrees of freedom for treatment.

TABLE

INDIVIDUAL COMPARISONS AND CALCULATIONS

Block treatment yield		I								II							
		(1) 101	n 100	k 205	nk 201	m 312	nm 373	km 398	nkm 450	(1) 87	n 128	k 270	nk 334	m 323	nm 324	km 423	nkm 471
Comparisons Blocks	B_1	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−
	B_2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	B_3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Treatment	N	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
	K	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
	M	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
	NK	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+
	NM	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+
	KM	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+
	NKM	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+
Error N	B_1	−	+	−	+	−	+	−	+	+	−	+	−	+	−	+	−
N	B_2	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
N	B_3	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
K	B_1	−	−	+	+	−	−	+	+	+	+	−	−	+	+	−	−
K	B_2	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
K	B_3	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
M	B_1	−	−	−	−	+	+	+	+	+	+	+	+	−	−	−	−
M	B_2	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
M	B_3	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
NK	B_1	+	−	−	+	+	−	−	+	−	+	+	−	−	+	+	−
NK	B_2	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+
NK	B_3	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+
NM	B_1	+	−	+	−	−	+	−	+	−	+	−	+	+	−	+	−
NM	B_2	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+
NM	B_3	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+
KM	B_1	+	+	−	−	−	−	+	+	−	−	+	+	+	+	−	−
KM	B_2	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+
KM	B_3	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+
NKM	B_1	−	+	+	−	+	−	−	+	+	−	−	+	−	+	+	−
NKM	B_2	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+
NKM	B_3	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+
Check		−	−	−	−	−	−	−	+31	−	−	−	−	−	−	−	+15

Calculation of total sum of squares

$$\Sigma x = 9331$$
$$n = 32$$
$$\bar{x} = 291.59375$$
$$\Sigma x^2 = 3187611.00000$$
$$(\Sigma x)^2/n = 2720861.28125$$
$$\Sigma(x-\bar{x})^2 = 466749.71875$$

III

FOR RANDOMIZED BLOCK EXPERIMENT

III								IV								Sum	Sum of squares Divisor	$\frac{(\text{Sum})^2}{\text{Divisor}}$	Effects Divisor	$\frac{\text{Sum}}{\text{Divisor}}$ or effect in lbs. per plot or bushels per acre
(1) 100	n 80	k 272	nk 306	m 324	nm 338	km 407	nkm 449	(1) 131	n 103	k 302	nk 272	m 324	nm 361	km 445	nkm 437					
−2	−2	−2	−2	−2	−2	−2	−2									−73	16	333.06		
																83	48	143.52		
+	+	+	+	+	+	+	+	−3	−3	−3	−3	−3	−3	−3	−3	−169	96	297.51		
−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	333	32	3465.28	16	20.8
−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	2271	32	161170.03	16	141.9
−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	2987	32	278817.78	16	186.7
+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	105	32	344.53	16	6.6
+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	161	32	810.03	16	10.1
+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	−669	32	13986.28	16	−41.8
−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−63	32	124.03	16	−3.9
+2	−2	+2	−2	+2	−2	+2	−2									−1	16	0.06		
																143	48	426.02		
−	+	−	+	−	+	−	+	+3	−3	+3	−3	+3	−3	+3	−3	449	96	2100.01		
+2	+2	−2	−2	+2	+2	−2	−2									−133	16	1105.56		
																3	48	0.19		
−	−	+	+	−	−	+	+	+3	+3	−3	−3	+3	+3	−3	−3	123	96	157.59		
+2	+2	+2	+2	−2	−2	−2	−2									57	16	203.06		
																−7	48	1.02		
−	−	−	−	+	+	+	+	+3	+3	+3	+3	−3	−3	−3	−3	−49	96	25.01		
−2	+2	+2	−2	−2	+2	+2	−2									−49	16	150.06		
																−85	48	150.52		
+	−	−	+	+	−	−	+	−3	+3	+3	−3	−3	+3	+3	−3	293	96	894.26		
−2	+2	−2	+2	+2	−2	+2	−2									129	16	1040.06		
																−43	48	38.52		
+	−	+	−	−	+	−	+	−3	+3	−3	+3	+3	−3	+3	−3	−187	96	364.26		
−2	−2	+2	+2	+2	+2	−2	−2									−35	16	76.56		
																41	48	35.02		
+	+	−	−	−	−	+	+	−3	−3	+3	+3	+3	+3	−3	−3	−97	96	98.01		
+2	−2	−2	+2	−2	+2	+2	−2									−63	16	248.06		
																49	48	50.02		
−	+	+	−	+	−	−	+	+3	−3	−3	+3	−3	+3	+3	−3	109	96	123.76		
																5613	1564			
−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−17	5613	1561			

Summary of analysis of variance

	D/F	Sum of squares
Blocks	3	774.09
N	1	3465.28
K	1	161170.03
M	1	278817.78
NK	1	344.53
NM	1	810.03
KM	1	13986.28
NKM	1	124.03
Error	21	7287.63
Total	31	466779.68

Yates has done this fully. In so doing he placed in a table the signs indicating the algebraic sums from which the individual treatment comparisons may be computed. I shall use an extension of this table for all the computations presented by Yates and to show the relation between the design of this $2\times 2\times 2$ factorial experiment and the analysis of variance appropriate to it. The indicated operations and the completed calculations for each of the 31 appropriate comparisons among the 32 plot yields are given in Table III.

From the many possible sets of comparisons among the 4 main block totals, I have selected one which is easily formed. Thus, for one degree of freedom, the total yield for block II is subtracted from that for block I, for a second, twice the total yield of block III is subtracted from the total of blocks I and II, and for the third, three times the sum of the yield of block IV is subtracted from the sum of the yields of blocks I, II, and III. By a similar scheme, the signs may be written for the 3 main effects. Thus, for effect of nitrogen, all plots receiving nitrogen are given a plus sign and all those not receiving nitrogen a minus sign and similarly the signs are assigned for potash and barnyard manure. Since the remaining 25 degrees of freedom are secured by multiplying one or more of these 6 together they should be checked carefully. The first condition that must be fulfilled is that the sum of the coefficients in any line must be zero. The second is that the sum of the products of corresponding coefficients in each combination of two lines must be zero.

These conditions being fulfilled, the remaining 4 treatment comparisons are derived from the 3 main effect comparisons by multiplication. Thus, the comparison for the interaction which involves nitrogen and potash (NK) is formed by multiplying the coefficients in the N line by the corresponding ones in the K line; that for the interaction between nitrogen and barnyard manure (NM) is formed by multiplying the coefficients in the N line by the corresponding ones in the M line; that for the KM is formed by multiplying the coefficients in the K line by the corresponding ones in the M line; and the comparison for the triple interaction (NKM) may be formed by taking the product of corresponding coefficients in the three lines, N, K, and M or by multiplication of corresponding coefficients in one of the following combinations of lines N and KM, K and NM, or M and NK. These 4 new comparisons must be checked to make certain they fulfill the two criteria given above.

The estimate of error in this example is based on the failure of the treatments to produce the same result in the different blocks, that is, on the interaction of treatments and blocks. The comparisons for error, then, are formed by multiplication just as the treatment interactions

were above. Each of the 7 treatment comparisons is multiplied term by term by each of the 3 block comparisons to produce the 21 error comparisons. Before proceeding further the 31 comparisons must be checked to be sure they fulfill the two given criteria.

Having determined that the 31 functions are orthogonal the check function is formed by summation. As in Table I, the sum for any row is the algebraic sum of the individual yields indicated by the function in that row and the sum of squares divisor for any row is the sum of squares of the coefficients in that row. Another column of divisors, which may be called the effects divisors, is added for obtaining the main effects and interactions in the sense used by Yates (8). An effects divisor for any row is the sum of the positive coefficients in that row or, what amounts to the same thing, one-half the sum of the absolute values of the coefficients.

The treatment sums are identical with those given by Yates (8) in Table 7. The effects which are given here in bushels per acre, if converted to English tons per acre also agree with those given by Yates. The results of the analysis of variance are given in the Summary of Analysis. The total of the sums of squares must check with the total sum of squares calculated directly from the individual yields. Thus, each of the 31 degrees of freedom has been calculated in an easy and convenient manner. These are easily assembled to produce a typical analysis of variance summary. However, the greatest value of this presentation is not as an aid to computation but as a means of explaining just what an orthogonal comparison is, its correspondence to a degree of freedom, and the unique relation between the form of analysis and an experimental arrangement or design.

This method of presentation has been especially helpful in dispelling the confusion which the device known as confounding has produced in some of my students and co-workers. To illustrate, we will do as Yates (8) did, reconstruct the analysis of this experiment on the supposition that it was designed so as to confound the triple interaction with blocks and that the resulting yields were identical with those obtained. This arrangement is indicated in Table IV. All the comparisons in Table III have been put in Table IV with the addition of 4 more for blocks to provide 7 comparisons or degrees of freedom for the 8 blocks.

We now appear to have 35 comparisons or degrees of freedom. This is due to the fact that not all are independent or orthogonal as shown by the failure of the check function to check. Upon examination, we find that the contribution to the total sum of squares corresponding to the triple interaction, NKM, is identical with that for the fourth partition for blocks. This comparison must be deleted from treatments since

TABLE

INDIVIDUAL COMPARISONS AND CALCULATIONS FOR

Block treatment yields	I A				I B				II A				II B			
	(1) 101	nk 201	nm 373	km 308	n 100	k 265	m 312	nkm 450	(1) 87	nk 334	nm 324	km 423	n 128	k 270	m 323	nkm 471
Comparisons																
Blocks B_1	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−
B_2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B_3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B_4	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
$B_1 \times B_2$	−	−	−	−	+	+	+	+	+	+	+	+	−	−	−	−
$B_1 \times B_3$	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
$B_2 \times B_3$	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
Treatments N	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+
K	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
M	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
NK	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+
NM	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+
KM	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+
NKM	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
Error N B_1	−	+	+	−	+	−	−	+	+	−	−	+	−	+	+	−
N B_2	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+
N B_3	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+
K B_1	−	+	−	+	−	+	−	+	+	−	+	−	+	−	+	−
K B_2	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
K B_3	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+
M B_1	−	−	+	+	−	−	+	+	+	+	−	−	+	+	−	−
M B_2	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
M B_3	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
NK B_1	+	+	−	−	−	−	+	+	−	−	+	+	+	+	−	−
NK B_2	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+
NK B_3	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+
NM B_1	+	−	+	−	−	+	−	+	−	+	−	+	+	−	+	−
NM B_2	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+
NM B_3	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+
KM B_1	+	−	−	+	+	−	−	+	−	+	+	−	−	+	+	−
KM B_2	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+
KM B_3	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+
NKM B_1	−	−	−	−	+	+	+	+	+	+	+	+	−	−	−	−
NKM B_2	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
NKM B_3	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
Check	−5	−5	−5	−5	+3	+3	+3	+35	−3	−3	−3	−3	+	+	+	+17

Summary of analysis

	D/F	Sum of squares
Blocks	7	1310.07
N	1	3465.28
K	1	101170.03
M	1	278817.78
NK	1	341.53
NM	1	810.03
KM	1	13080.28
Error	18	6835.70
Total	31	400770.60

IV

RANDOMIZED BLOCK EXPERIMENT WITH CONFOUNDING

III *A*				III *B*				IV *A*				IV *B*				Sum	Sum of squares Divisor	(Sum)²/Divisor Individual contribution to total sum of squares
(1) 100	*nk* 300	*nm* 338	*km* 407	*n* 80	*k* 272	*m* 324	*nkm* 440	(1) 131	*nk* 272	*nm* 301	*km* 445	*n* 103	*k* 302	*m* 324	*nkm* 437			
																−73	16	333.00
−2	−2	−2	−2	−2	−2	−2	−2									83	48	143.52
+	+	+	+	+	+	+	+	−3	−3	−3	−3	−3	−3	−3	−3	−100	96	207.51
−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−63	32	124.03
																−63	16	248.06
+2	+2	+2	+2	−2	−2	−2	−2									49	48	50.02
−	−	−	−	+	+	+	+	+3	+3	+3	+3	−3	−3	−3	−3	109	96	123.76
−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	333	32	3465.28
−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	2271	32	161170.03
−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	2987	32	278817.78
+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	105	32	344.53
+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	161	32	810.03
+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	−669	32	13986.28
−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−63	32	124.03
																−1	16	0.06
+2	−2	−2	+2	−2	+2	+2	−2									143	48	426.02
−	+	+	−	+	−	−	+	+3	−3	−3	+3	−3	+3	+3	−3	449	96	2100.01
																−133	16	1105.56
+2	−2	+2	−2	+2	−2	+2	−2									3	48	0.17
−	+	−	+	−	+	−	+	+3	−3	+3	−3	+3	−3	+3	−3	123	96	157.59
																57	16	203.06
+2	+2	−2	−2	+2	+2	−2	−2									−7	48	1.02
−	−	+	+	−	−	+	+	+3	+3	−3	−3	+3	+3	−3	−3	−49	96	25.01
																−49	16	150.06
−2	−2	+2	+2	+2	+2	−2	−2									−85	48	150.52
+	+	−	−	−	−	+	+	−3	−3	+3	+3	+3	+3	−3	−3	203	96	504.20
																129	16	1040.06
−2	+2	−2	+2	+2	−2	+2	−2									−43	48	38.52
+	−	+	−	−	+	−	+	−3	+3	−3	+3	+3	−3	+3	−3	−187	96	364.26
																−35	16	76.56
−2	+2	+2	−2	−2	+2	+2	−2									41	48	35.02
+	−	−	+	+	−	−	+	−3	+3	+3	−3	−3	+3	+3	−3	−97	96	98.01
																−63	16	248.06
+2	+2	+2	+2	−2	−2	−2	−2									49	48	50.02
−	−	−	−	+	+	+	+	+3	+3	+3	+3	−3	−3	−3	−3	109	96	123.76
																5645	1696	467325.55
−1	−1	−1	−1	−1	−1	−1	−1	+1	+1	+1	+1	−3	−3	−3	−10	5660	2080	

it has been confounded with blocks by the design. Likewise the last three contributions to error which are interactions involving *NKM* and original blocks have been confounded and must be deleted from error. The analysis of variance may now be summarized as shown in Table IV.

The device known as partial confounding offers further use for this method of presentation. Some students and also some experimenters find it difficult to determine the arrangement of treatments in sub-blocks which will produce the partial confounding of the desired interactions or to determine which interactions are partially confounded by a given arrangement. In arranging the treatments totally to confound the triple interaction as may be observed in Table IV, the fertilizer treatments were assigned so that all minus terms of the triple interaction functions would fall in sub-blocks *IA*, *IIA*, *IIIA*, and *IVA*, and all plus terms in *IB*, *IIB*, *IIIB*, and *IVB*. Partially to confound the *NKM* interaction in blocks *IA* and *IB*, the *NK* interaction in blocks *IIA* and *IIB*, the *NM* interaction in blocks *IIIA* and *IIIB*, and the *KM* interaction in blocks *IVA* and *IVB*, requires only that the plus and minus terms for an interaction be grouped in the desired pair of sub-blocks.

I have attempted to show how the tabulation of individual comparisons may assist one in understanding and in helping others to understand various experimental designs and the corresponding appropriate analyses. Though the scheme may be used as a form of computation, it becomes cumbersome when the number of comparisons becomes large. However, for a reasonable number of observations, the table of comparisons can be set up in such a manner, when the experiment is designed, that the analysis of the results becomes a matter of mere routine calculations.

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SOME PRACTICAL USES FOR HYPERBOLIC GRIDS

By Herbert G. Smith[1]

So much statistical work is performed with approximate data that this writer has long held the opinion that approximate methods also are frequently justified, both for treating the data and for rough checking purposes. Again, where approximate solutions will serve, these may, in many instances, be obtained readily and easily by graphic methods, particularly where the functions considered will plot to straight lines, making interpolation easy.[2]

Hyperbolic, or reciprocal, grids are a relatively unknown and, for that reason, rarely used type of graph upon which certain functions will plot either as a continuous linear curve or as a broken series of linear curves. For rate studies and for purposes of obtaining weighted arithmetic averages graphically, the hyperbolic grid will frequently render great service. The justification of the present paper is that nearly all standard texts on graphics seem to ignore the hyperbolic grid entirely, or give it inadequate treatment. Perhaps the best generally available explanation of this graph and its usage occurs respectively in the graph paper catalogs of Keuffel & Esser Company, Inc., and of the Codex Book Company, Inc.; and, in the latter, references are made to two articles and to a Codex leaflet which further describe the uses of the hyperbolic grid. To whom should go the credit for having devised this type of graph seems to be unknown, for the present author has nowhere been able to note reference to its originator.

Ready-prepared hyperbolic graph papers, conventionally on paper $8\frac{1}{2} \times 11$ in size, may be obtained from manufacturers of graph papers, and, on these commercial papers, rulings are sufficiently numerous to provide for reasonably accurate plotting and interpolation. The horizontal axis, or axis of abscissas, is calibrated according to the reciprocals of the numbers printed on this scale. The vertical scale, or axis of ordinates, is customarily graduated arithmetically, and the numerical values given to these graduations may be large or small as desired. The vertical scale is graduated from zero (0) in both positive and negative directions, if desired; the horizontal scale conventionally begins with unity (1) and is calibrated positively to the right to infinity (∞).

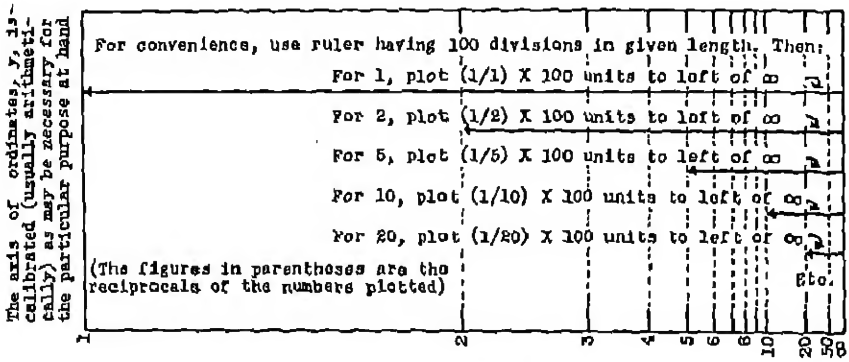
[1] The writer wishes to acknowledge the courtesy of Mr. R. von Huhn, Washington, D.C., who kindly read and criticized the first draft of this paper, and some of whose suggestions have been incorporated in this revision.

[2] See, for example, the writer's *Figuring with Graphs and Scales*, Stanford University Press, 1938, a small treatise devoted largely to explanations and illustrations of logarithmic graphs and scales for "figuring."

By plotting various functions of x (that is, the y's) to infinity on the abscissa scale, the weighted mean over any abscissa designation may be found for the ordinate values up to that abscissa point. This is because the various means lying on any one given straight line, if plotted through converge upon the same point at infinity. The same results

FIGURE I

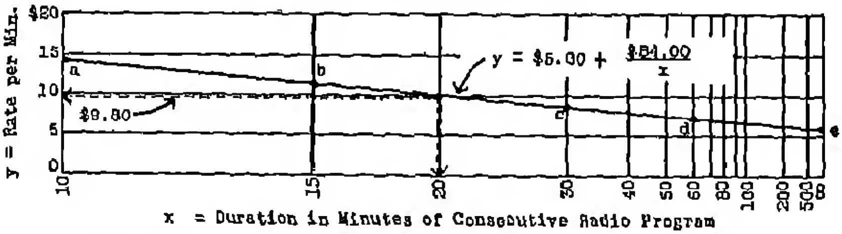
LAYOUT OF RECIPROCAL SCALE



The axis of abscissas, x, is normally the reciprocal scale. Figures may be used as they appear, or as they would appear if each were multiplied or divided by an integral power of 10. Normal range is from 1.00 to ∞ (infinity), but fractional quantities may be shown. Intermediate calibrations are not shown here, but may be added as circumstances indicate.

FIGURE II

RADIO TIME RATES



Published Rates and Plotting Points

Published Rates	Minutes x	Rate per Min. y
1 Hour $120	60	$ 7.00
½ Hour 252	30	8.40
¼ Hour 168	15	11.20
⅙ Hour 140	10	14.00

(1) These data exhibit a linear relationship on this type of grid, converging upon the same point at infinity. The xy points for plotting are located as on any type of grid, and the curve is projected to infinity.

(2) Any function that is linear on this type of grid may be represented by the general equation $y=a+b/x$, where y represents ordinate numerical values, a is the y-intercept at infinity, x represents abscissa numerical values, and b is a constant.

(3) Merely by substituting $1/x$ for x in the conventional arithmetic linear equation, $y=a+b\,x$, a *particular* equation may be found by the wellknown method of least squares. As an illustration of

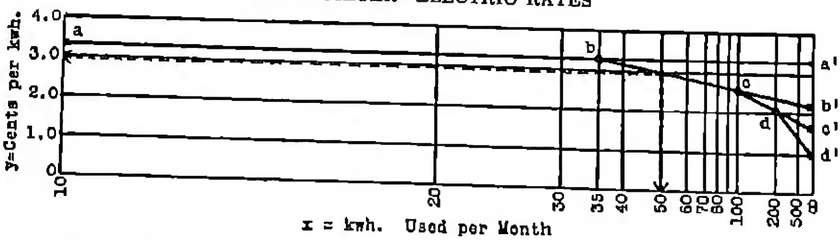
(4) use, above 20 minutes on graph interpolate $9.80—the rate per minute for a consecutive radio program of 20 minutes duration.

may, of course, easily be obtained by ordinary computation, yet, as will be noted below, once the graphic process is understood it will frequently be found to be a very rapid method and will yield results sufficiently precise for approximate purposes. Further, as in the case of electric rates, below, for example, once the rates are plotted the graph may be retained and the average rate for a given usage may, whenever desired, be approximated easily and quickly from the graph.

Figure II, Radio Time Rates. The radio rates given in conjunction with Figure II, and adapted for plotting thereon, are from the recent rate schedule of a prominent West Coast station and are fairly representative of common radio rate structures. Although the rate card lists only the rates given, if it is assumed that rates for intermediate periods of time are arrived at by similar processes, then, easily and readily, they may be interpolated from Figure II without computation.

FIGURE III

"BLOCK-METER" ELECTRIC RATES



Published Rates and Plotting Points

Number of kwh. Used per month		Cumulated kwh. x	Cents per kwh. y
First	35	35	3.3
Next	65	100	2.2
Next	100	200	1.6
Over	200	Over 200	1.0

(1) From origin to infinity, draw horizontal line aa' at 3.3¢. This rate applies to all usage up to 35 kwh. per month, inclusive.

(2) From 35 kwh. on the 3.3¢ curve to 2.2¢ at infinity, draw line bb', and average rate per kwh. for usages from 35 kwh. to 100 kwh. may be interpolated from bb'.

(3) Draw curve cc' from bb' and 100 kwh. to 1.6¢ and infinity. Average rates for usage from 100 kwh. to 200 kwh. lie on curve cc'.

(4) Draw curve dd' from cc' and 200 kwh. to 1.0¢ and infinity. Average rates for usage over 200 kwh. per month lie on curve dd'.

(5) Illustration: The dotted lines indicate for 50 kwh. per month an average rate just under 3.0¢.

Figure III, Block-Meter Electric Rates. Perhaps it is in the field of electric and gas rates that the so-called "classical" use of hyperbolic grids may be found. In any event, it is to these fields that their use has, so far, largely been restricted.

The domestic lighting rates given in conjunction with Figure III and adapted for plotting thereon, are those recently published for a relatively small Pacific Coast municipal utility. The average rate per kwh. for a usage of 150 kwh. per month, for example, would ordinarily be

found in the following manner, similar to that for determining any weighted average:

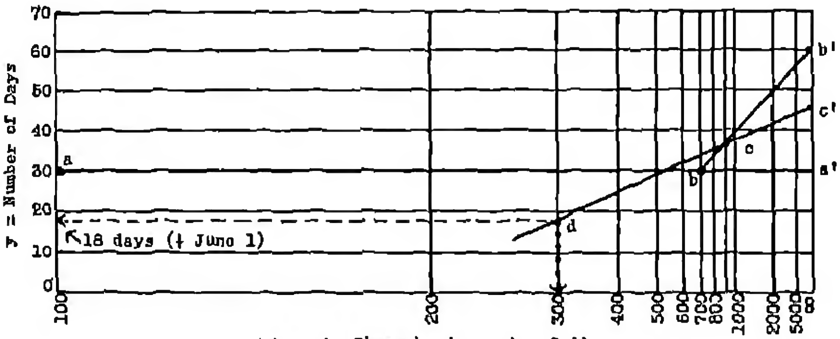
$$\frac{35 \text{ kwh.} \times 3.3¢ + 65 \text{ kwh.} \times 2.2¢ + 50 \text{ kwh.} \times 1.6¢}{150 \text{ kwh.}}, \text{ or}$$

$$\frac{\$1.155 + \$1.430 + \$0.80}{150}, \text{ or } 2.26-¢.$$

How much more easy it is merely to glance at the graph, once the data are plotted, and to determine visually that the approximate aver-

FIGURE IV

AVERAGING ACCOUNTS



The Account and Plotting Points

Date	Due	Amount	Cumulated Amounts x	Days from June 1 y
6/1	7/1	$700 dr	$700	30
6/1	8/1	200 dr	900	60
6/1	7/17	600 cr	300	46

(1) From origin to infinity, draw horizontal line *aa'* at 30 days. The $700 item lies on this line.

(2) From $700 on *aa'* draw *bb'* to 60 days and infinity. The $900 sum lies on this line.

(3) From $900 on *bb'* draw *cc'* to 46 days and infinity, projecting *cc'* backwards to beyond *d*, so that the sum $300 will lie on this line.

(4) Over $300, interpolate horizontally to the left-scale the number of days from June 1 (focal date) to average date. The dotted lines indicate that this is 18 days.

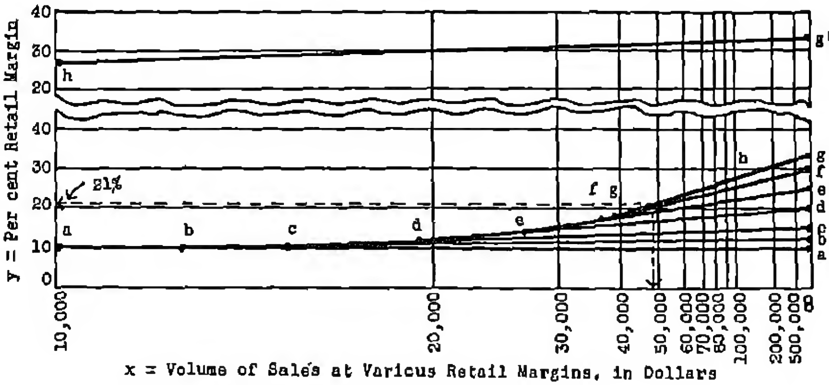
age rate is about 2.25¢ per kwh.! And the plotting, itself, once the use of the graph is grasped, takes considerably less time than does the foregoing computation.

Figure IV, Averaging Accounts. Statistics has often been defined broadly as being the "handmaiden of accountancy." Here's one place—rather unconventional—where they can work hand in hand. A reasonably simple problem in weighted averages, "averaging an account" is, as illustrated with hypothetical data on Figure IV, even more simple graphically.[3]

Figure V, Equalizing Sales and Margins. Federal enabling laws, such as the Miller-Tydings Act, were designed to eliminate the popular retail-store practice of price-leaders, sold at or below cost. Recent difficulties in Colorado, where in conforming to State law certain merchants ran afoul of Federal law indicate that these enabling laws are not wholly effective. An article in the *Radford Grocery News* for November 1940,[4]

FIGURE V

EQUALIZING SALES AND MARGINS



Sales and Plotting Points

Sales by Departments	Cumulated Sales x	Retail Margin y
$12,000	$12,000	10 %
2,400	14,400	12½ %
4,800	19,200	15 %
7,200	26,400	20 %
9,600	36,000	25 %
2,400	38,400	30 %
9,600	48,000	33⅓ %

(1) From origin (left-margin) to infinity, draw horizontal line *aa′* at 10%. This line represents average per cent retail margin on sales volume up to $12,000.

(2) From $12,000 on curve *aa′*, draw *bb′* to infinity and 12½ %. On this curve, *bb′* lie sales volumes from $12,000 to $14,400, inclusive.

(3) In similar fashion, from data in table herewith, draw curves *cc′*, *dd′*, *ee′*, *ff′* and *gg′*.

(4) Then, from the graph, for any volume of sales segregated as in the table, the average rate of margin for that volume may be interpolated. Thus, if the average retail margin for the store's total sales ($48,000) is desired, this margin which is approximately 21 %, may be read. (See dotted lines.)

(5) In connection with Figure I, it was mentioned that figures on the axis of abscissas may be used as they appear or, depending upon circumstances, as they might appear were each multiplied or divided by an integral power of 10 . . . . The upper section (broken) of the accompanying graph is a repetition of the upper part of the lower section, but with figures on the axis of abscissas presumed to be multiplied by 10 in each instance. The curve *hg′* on this upper section, then, is a repetition in less condensed form of that portion of curve *gg′* on lower section lying between *h* and *g′*; that is, between $100,000 and infinity. In similar fashion, scales approaching infinity may be expanded so as to facilitate plotting and reading.

[3] For the ordinary method of computation, the reader is referred to almost any text of intermediate or higher grade on accountancy. Here, other than for the graphic outline, space is wanting for a more complete description.

[4] External house organ published monthly for customers of the J. M. Radford Grocery Company, a Texas company operating a chain of wholesale outlets in the Southwest.

explaining for the benefit of grocers how they may manipulate their margins relative to sales so as to sell some merchandise at cost and yet average a desired margin on all sales, offers another instance.

Figures presented in connection with Figure V and adapted for use thereon, are borrowed from a table appearing in *Progressive Grocer*, New York, for March 1935, illustrating an article entitled "How Grocery Products May Be Marked Up to Average 20% on Sales." As with the averaging process outlined in connection with electric rates, above, the problem here is again one of obtaining a weighted average. But, again, once the use of the graph is understood, the process, for approximate purposes, may be carried out much more quickly by using a ready-prepared hyperbolic grid.

Other Uses. There are many instances in which the use of a hyperbolic grid for "figuring" will save time and temper and will promote accuracy. In other instances, this type of graph can render a complementary service, namely, that of providing for a reasonably accurate rapid check on computation performed in the ordinary manner. Several suggested uses follow:

(1) The five-day week at schedule wages, with time-and-one-half for overtime is becoming prevalent. In many instances it is important to know what the average rate of pay is per hour under such conditions. By adaptation of methods illustrated here, a hyperbolic graph will supply this information quickly and easily.

(2) What is the average rate of turnover of merchandise in a given store of several departments, the turnover rate being different in each department? This, again, is a simple showing on a hyperbolic grid, being a problem almost exactly similar to the one of equalizing sales and margins, Figure V.

(3) Another interesting usage, comparable to the block-meter electric rates as illustrated, is in connection with income tax. If an income tax schedule listing "amounts of surtax net income" and "rate per cent" is examined, it will be noted that they are arranged in blocks, just as are the electric rates described. And as with the electric rates, these income tax figures may be plotted on hyperbolic paper so as to show, for any "amount of surtax net income," *one* percentage figure applying to it. *Caution:* This usage is suggested merely as a check on other computation; the results obtained graphically are not sufficiently precise to serve alone. For reporting figures, one must continue to use those necessarily obtained by the tedious computation of "total surtax" block by block.

NOTES AND DISCUSSIONS

Methods of Family Living Studies, A Reply to the Review

Though Professor Zimmerman seems to disqualify himself as a reviewer of *Methods of Family Living Studies* by confessing his contempt for budget investigators, readers of the review in the December number of this JOURNAL may gain an entirely false impression of the report, which, except for a short chapter on purposes of family living studies, is devoted exclusively to methods. The statement is made in the review that the appendix contains "tabular material concerning the 30 illustrative studies, so that the student may compare his findings with those of others." The appendix contains no findings, but merely shows what detail of method is followed in the different studies analyzed. The findings of these recent family living studies are summarized in two articles in the May and June numbers of the *International Labour Review* for 1939, and referred to in the preface and elsewhere in the report.

The reviewer remarks that the document was "supposedly printed to inspire the development of similar studies in other regions and other countries." In fact, it was prepared to be of assistance to those who were carrying out such studies.

Professor Zimmerman would like to know what a year of average prosperity is, apropos of a statement that in planning budget studies a year of average prosperity is usually chosen. It should be sufficiently clear that since the period is chosen in advance, the year of average prosperity merely avoids the extremes of prosperity and depression. Since official family living studies in the great majority of cases are made with a view, among other purposes, to furnishing a base for cost of living indices, the reason for avoiding extremes is clear.

Professor Zimmerman adds some generalizations as to "lack of originality," lack of explanations in terms of principles, and saying "what has been said *ad nauseum*" (sic): the only evidence offered is the remark thus cited in regard to average prosperity. He adds the query, "Why can't social scientists be encouraged to study life as it is?" Does the reviewer mean to suggest that family budget investigators study family living as it is not?—a chief preoccupation of modern studies (brought out in the report) is the emphasis upon sampling to make sure that details of family living as found in the families studied are representative and significant. Or does he mean to support the principle that the family budget investigator should issue forth without plan or method and study "life as it is?" Is this the originality that the reviewer fails to find in the report? In any case, the report does not purport to cover "life" but merely family "living" with its economic meaning and limitations.

The final sentence in the last paragraph of the review and the bold generalization that leads up to it may be considered as specimens by which to

judge the quality of the reviewer's generalizations. "The reviewer is of the opinion that . . . the average outlook of the budget investigator is not up to that of the Political Arithmeticians. The reason is due in part to official reports such as this." For this generalization in regard to the average outlook of the budget investigator no evidence is presented; no indication is given as to whether the conclusion is based on a sample or on a complete analysis; no method is apparent by which an average outlook can be calculated—how the outlooks of budget investigators in the front rank, like Faith Williams and Ernst Abramson for example, can be averaged with benighted outlooks more restricted than those of the Political Arithmetician to yield an average result "not up to that of the Political Arithmeticians." But the crucial defect in the generalization is the absence of the date to which the evidence and therefore the conclusion relate. One would have supposed that the average outlook of budget investigators would be in process of rapid improvement, if only from the influence of the writings of Professor Zimmerman. Of the budget studies utilized in the report under discussion over two-thirds were published subsequent to those included in the Williams-Zimmerman annotated list. Of course if the date does not matter, i.e. if the outlook of the average outlook of the budget investigators is hopeless, blame for its continuance is unwarranted. "The reason is due in part to official reports such as this." This generalization and assessment of blame immediately raises the questions, what official reports are the basis of this inference? And what evidence is there that any official reports are a cause of the average budget investigator's outlook being "not up to that of the Political Arithmetician?" Or perhaps the reviewer means that the absence of official reports of a superior type as conceived in the reviewer's imagination is the cause of the said average outlook? What is there to connect the present document with such real or imaginary reports? If I might venture to help the reviewer to clarify his thought, he seems to wish to say that he thinks I have missed an opportunity to educate the budget investigator. But to educate the budget investigator is the function of the professor: my task was the more modest one of furnishing a manual of methods to aid in making family living studies.

In short, in order to form a fair judgment of the report in relation to its purpose, the reader must evidently turn to the report itself.

In conclusion, the excellent *Studies of Family Living in the United States and Other Countries* by Faith M. Williams and Carle C. Zimmerman was consulted and utilized in the preparation of the report; reference to it was inadvertently omitted and will appear in future editions.

ROBERT M. WOODBURY

International Labour Office
Montreal

Rejoinder

My review which had to be limited to a very few words tried to say shortly what I had already said in *Consumption and Standards of Living* (New York,

1936, p. 475 *et passim*) and in two other books I have written on the subject, namely, *Family and Society* (with M. E. Frampton) New York, 1935, and *Studies of Family Living*, U.S.D.A. Misc. Publ. #223, 1935 (with F. M. Williams). In these previous analyses I have repeatedly stressed the crying need for a virile development of budget investigations, not particularly in quantity but especially in quality and in the application of *meaning* to the study of conceptions tied about the standard of living. If my terseness is interpreted as "contempt for budget investigators," it is only self-criticism or misinterpretation.

If this report is to guide investigations in other countries we may well ask what countries. Certainly the Russians, the Germanic region in Central Europe, the Scandinavian countries, the Chinese, the Japanese, the Indians and many other sections of the British Empire have already demonstrated by their several hundreds of careful budget investigations that they are acquainted with, and even beyond the methodological principles laid down in this report. If this report is to stimulate budget investigations where they are not already quantitatively well-developed, it should be printed in Spanish or Portuguese for certain of the Latin American countries, or in the native languages for some sections of Africa.

If, on the other hand, this report is to be used in the countries which have already produced budget investigation in great detail, it should, in the opinion of the reviewer, make a number of forward steps not particularly stressed in the document as it is. The problem of double entry accounting mentioned passingly here on pages 41–42 should be given more attention. If this is done, the question of outgo for future consumption should be given a definite place in the study ranking it with the same importance and dignity as consumption and non-consumption outgo. Further the whole question of income in kind and of the handling of problems of peasants and part time farmers, most prevalent groups outside of England and northeastern United States of America, should be given a broad and systematic value treatment.

My criticism of artificial limitations upon budget investigations stressed in this report by the use of the "year of average prosperity" phrase should not be thrown lightly aside. Investigators have at various times limited themselves to those renting homes in order to find out how much is paid for rent. In this particular case, the majority of the workers owned their homes. Another series of investigators limited themselves to "normal" families which were so defined that a large part of the industrial population then could not qualify for the investigation. Another particularly serious case was the picking of families fully employed earning at least $1000 a year in a period when a large proportion of the working population in that country was unemployed and (or) earning less than $1000 a year. As a result the conclusions do not apply to the given country or the given time but only to a somewhat unclear nominalistic segment of the population under investigation.

Whatever I said in the review, even if erroneous, was a thoughtful conviction based upon many years of analysis of the problem. The approach by

the Political Arithmeticians may be illustrated by the works of Sir William Petty. In my opinion these early studies stood out because the authors took the problem of the standard of living of the people and tried to probe it without any artificial limitations. Budget investigations have several centuries of history behind them. If now an official report, like this one, does not bring in the most advanced techniques and keep the analysis to a meaningful level such investigations can and have tended to become compilations of data having no inner organic meaning.

CARLE C. ZIMMERMAN

Harvard University

Reply to the Rejoinder

The reviewer now suggests that "the problem of double entry accounting mentioned passingly here on pages 41–42 should be given more attention." It is given more attention in and indeed forms the basis for the structure of sections 4 and 5 of Chapter IV. "The question of outgo for future consumption should be given a definite place in the study . . . " This subject, i.e. savings laid by for the future, is discussed under the heading "Other disbursements," pp. 70–71. The topic of income in kind is treated in conjunction with each of the specific sources of income where it is a factor, pp. 54–59, though it is of relatively little importance in studies of family living except among farmers and agricultural workers. The whole series of problems connected with family living studies among farmers and farm laborers is specifically excluded from the scope of the report, as stated on p. 5.

The rest of Professor Zimmerman's remarks seem irrelevant except as they throw light upon the reviewer's mental attitude. One may well be puzzled at the contradiction between the opinion now expressed that "the Russians, the Germanic region in Central Europe, the Scandinavian countries, the Chinese, the Japanese, the Indians and many other sections of the British Empire have already demonstrated by their several hundreds of careful budget investigations that they are acquainted with, and even beyond [sic] the methodological principles laid down in this report," and the opinion expressed in the review that "the average outlook of the budget investigator is not up to that of the Political Arithmeticians." (I interpreted the latter statement as contempt for the budget investigator.) The latter is doubtless one of the "thoughtful convictions based upon many years of analysis of the problem." The same can scarcely be said for the former since it includes a reference to the report under review, and, judging by the above examples, it does not appear that the reviewer is yet sufficiently familiar with the report to know what it contains.

Editions in French and Spanish are in preparation.

ROBERT M. WOODBURY

International Labour Office
Montreal

BOOK REVIEWS

GLENN E. MCLAUGHLIN
Review Editor

Canadians In and Out of Work, by Leonard C. Marsh. Montreal, Canada: McGill University. Social Research Series No. 9. 1940. xx, 503 pp. $3.50.

This book certainly lives up to its sub-title; it is perhaps the most concise and precise "survey of economic classes and their relation to the labour market" that has been made for any country. The distribution of the population among occupational and income grades, the regional and racial differentials, occupational mobility and access to educational facilities, the effects of boom and depression on the occupational structure, and the incidence of unemployment and relief are all set forth in statistical tables and figures easy to grasp. An outstanding success in conveying the information required is scored by the figures (22) showing the passage from school to work of young persons between the ages of 5 and 24, by the figures (20, a, b) showing the age-characteristics of occupational grades and the results of promotion, and by the table (35) showing the periods spent at school by persons in different occupational grades.

The facts thus accurately and succinctly measured are discussed intelligently and with a wide understanding of their relationships. The author even makes so bold as to tackle the problem of social stratification. What he says shows knowledge and insight, but the attempt to find (pp. 389–396) the "relative weight" of social classes, particularly the middle class, through existing statistics of occupation is a super-human task. The relative thickness and impermeability of social strata might be discovered in sample communities (typical of a country) by intensive field-work but not in my view by the use of necessarily somewhat superficial census data.

The functional as against the social grading of occupations is, on the other hand, most carefully considered—more carefully, indeed, than is usual either in the United States or in Britain. Managers are classed with proprietors; but "responsible" are distinguished from skilled workers, and intermediate classes of industrial workers and service occupations are inserted. There is, however, no attempt to classify by industry, so that it is not possible to measure how far the various economic activities entail a different occupational structure.

The author is not afraid of international comparisons and shows himself well versed in British, American, and Canadian sources. If the definitions are really comparable, it is important to note (Fig. 4 Table 11) the seemingly greater reliance placed on skilled workers in British industry; but on professional and managerial grades in the newer countries. Similarities also are brought out, particularly in the recruiting of leaders, which is so vital to successful democracies. In America as well as England there is a large waste (p. 416) "incurred by (the) misdirection of our intellectual resources." Chil-

dren who might profit by higher education often do not get it, while many who are not likely to profit do get it. The actual rulers of Anglo-Saxon democracy are also subjected to analysis by an occupational classification (Table 69) of Canadian legislators. The preponderance of lawyers over all other occupations is as apparent in Canada as in Britain and the United States.

The author's "social arithmetic" clearly calculates to some purpose and the final chapter discusses some implications of the statistical findings on public policy particularly the policy of coordinating education and working life, and of reducing the class differentials which the author's statistics have presented so ably.

P. SARGANT FLORENCE

University of Birmingham, England

Government and the Needy, A Study of Public Assistance in New Jersey, by Paul Tutt Stafford. Princeton, New Jersey: Princeton University Press. 1941. xiv, 328 pp. $3.00.

Professor Stafford's study of the relief problem in New Jersey is clearly a contribution to the fields of political science and public administration. The major part of the book contains a detailed and carefully documented account of the governmental administration of relief in New Jersey from colonial times to the present. The problems of administration and public policy, the development of relief functions in the Federal, state, and local governments are emphasized throughout. The author deplores the present confusion in relief organization resulting from the division of authority, frequently illogical and unclear, between various government agencies, and the lack of a consistent public policy for handling relief. The situation in New Jersey, analyzed in the light of its historical background and present development, is offered as a case study of a problem of national importance.

The story is a familiar one and could probably be duplicated in broad outline in many other states. The old poor law tradition, under which relief was a minor function of local government and which made little provision for any but the unfit and desperate, broke down in the early 'thirties under the impact of severe unemployment. Local relief agencies found themselves unable to cope with the large numbers of able-bodied unemployed who came to them for assistance. The state stepped in, earlier in New Jersey than in some other states, and then the Federal government. The story is familiar, but the detailed record is not easy to secure. Professor Stafford has filled in the outline with careful research, so that the intricacies of administrative relationships, statistical data on relief expenditures, costs, sources of revenue, case load, and other relevant facts are revealed in orderly fashion for New Jersey.

The first and last chapters deal with the relief problem in broader terms, giving the social and economic background and a program for reform. Professor Stafford believes that relief has become a permanent function of government and should be recognized as such, with a coordinated plan for han-

dling it at the various governmental levels. He disagrees with the emphasis of the Federal government on the temporary character of the work relief program, on the grounds that our economy has reached a declining phase and that unemployment will probably be permanent from now on. There is not space to argue this view here, except to remark that the decline of the extensive frontier need not mean that intensive frontiers will not be developed.

Few will disagree, however, that unemployment is one of our most important problems, that its relief will be necessary in some fashion for some time to come, and that its administration should be in government hands. Professor Stafford advocates Federal, state and local participation, under a grant-in-aid system from the Federal government. Direct administration would be carried on by state and local governments under standards set up by the Federal government. The success of the grant-in-aid system under the FERA will be questioned by many, yet in the field of categorical relief, Professor Stafford believes that it has been effective.

Social scientists in general will find this book useful as a reference for facts on relief administration, as exemplified by the New Jersey experience. To administrators and political scientists it will undoubtedly be of more general interest.

Elizabeth W. Gilboy

Committee on Research in the Social Sciences
Harvard University

Foundations of American Population Policy, by Frank Lorimer, Ellen Winston, and Louise K. Kiser. New York: Harper & Brothers. 1940. xiii, 178 pp. $2.50.

The principles enunciated in this work represent the views of the committee on population studies of the National Economic and Social Planning Association. The authors describe present and prospective American population trends and examine the probable implications of these trends for resource and labor problems, for the pattern of consumption, and for the level of investment and employment. Attention is given to the changing character of the family and of its rôle in American life, and to the relations between health, education, and recreation, on the one hand, and population change, on the other. In a final chapter principles of national policy are considered. The book is well organized and clearly written, and will prove useful to all who seek a compact picture of American population problems.

While much of the material is similar to that embodied in the reports of the National Resources Committee on demography and related problems, there is also a discussion of the Hansen-Keynes thesis that present demographic trends will almost necessarily entail a falling off in the level of investment and a consequent increase in unemployment. This thesis (present in the guise of a destroyer of the system of free enterprise) is not examined critically. While the relationship presupposed does exist in varying measure,

the actual nature of the relationship is far more complicated, in economic and sociological terms than the discussion suggests. For the present, dive bombers appear to be doing more than unimplemented analysis to dissipate this worry.

In the closing chapter the authors emphasize the need for a national population policy. They believe that while it is not possible to step up the rate of increase, even though it were desirable to do so, it may be possible to check the decline in net reproduction and stabilize the population at some level. A positive program is necessary, they indicate, in order that: (a) the economy can be adjusted to cessation of population growth; (b) steps may be taken to insure the replacement of the population; (c) present dysgenic tendencies may be checked; (d) a better distribution of the population in relation to economic opportunity may be effected.

J. J. Spengler

Duke University

The Scholarship of Junior Professional Appointees in the Government Service, by Lewis B. Sims. President's Committee on Civil Service Improvement. 1940. xxi, 228 pp.

Ever since the Federal government began recruiting young college graduates for the junior professional services, students of public service personnel have been wondering just what sort of material has been attracted. The policy of appointing young persons who allegedly have a superior general capacity, and who are to be assigned to suitable employment after they have been "shaken down," instead of trying to fill specific positions with persons possessing relevant but narrow competence, is a satisfactory procedure if the material supplied by the colleges is really superior.

Mr. Sims' statistical study of those appointed to junior professional positions carrying a salary of $2000 or more, from January 1935 to March 1939, answers part of this question. He tells us what the colleges think of the scholastic performance of the group. One of his tables summarizes his findings:

Scholastic Standing of Junior Professional Appointees, from January 1935 to March 1939

Fifth of Graduating Class	Percentage of Totals			Number
	Recruited through Civil Service Commission	Recruited Otherwise	Combined Recruitment	
1st	35	23	29	1256
2nd	26	24	25	1082
3rd	16	21	19	820
4th	13	17	15	668
5th	10	15	12	542

These figures are not reassuring. The 5190 appointees, most of whom are classified above, came from 130 different schools, in many of which scholastic standards are none too high, and yet 46 per cent are from the lowest three-fifths of their graduating classes. The President's Committee on Civil Service Improvement has a job to do, to persuade professors, deans, and college vocational advisors to hold up the public service as a career fit for the best. The state-supported schools are apparently less remiss in this respect: The University of California (at Berkeley), the University of Minnesota, Iowa State College, the University of Illinois, and the Pennsylvania State College furnished 727 of these young people, while Harvard, Columbia, Pennsylvania, Yale, and Princeton provided only 192, little more than a fourth as many. (This is not entirely explained by the disproportionately heavy recruitment in the Department of Agriculture.)

Mr. Sims' compilation was a painstaking one and includes hundreds of tables and breakdowns, by schools, services, and departments, but since it was confined to scholastic grades from non-comparable institutions, its usefulness is extremely limited. We shall be looking for more pertinent studies from the committee, touching among other things on capacity, adaptability, enthusiasm, and promotion.

James C. Charlesworth

University of Pennsylvania

Talents and Tasks, Their Conjunction in a Democracy for Wholesome Living and National Defense, by Truman L. Kelley. Harvard Education Papers No. 1. Cambridge, Massachusetts: Harvard University Graduate School of Education. 1940. 48 pp.

In the first few pages of this pamphlet we find an impassioned plea—almost a crusade—for democracy and a strong denunciation of totalitarian government. A broad national objective is proposed which is concerned with the problem " . . . so to utilize the talents of our differentially endowed and trained citizens as to maximize their satisfactions and their social productivity." It is proposed that this social objective be attained by a statistical analysis of variables for which computational steps are given in detail.

A rather ambitious program is outlined and although it is undoubtedly pointed in the right direction, considerable difficulty, much of it non-mathematical, would be encountered in making the proposal effective. It would require a much more thorough analysis of tasks and even of society itself, than we now possess. Abstractions such as "social utility," "individual well-being," "needs of the nation," "social usefulness," and "human problems of welfare" sound attractive until we try to translate them into specifics. Who will determine "needs?" Who will create jobs for certain talents? Will we permit innocuous but perhaps personally satisfying types of work? Interests do not always correlate with talent—what to do in a democratic society if a youth still *wants* to do that which he ought not to try to do? Perhaps true

democracy involves the right to fail! Society is a dynamic structure in which social utility may change rapidly particularly in times of crisis; by way of example, we need only call attention to the sudden and high importance which tool-makers have recently achieved.

One is inclined to feel that resolving techniques (statistical procedures) have now outstripped accumulative techniques (valid tests). Certain areas such as character and temperament are inadequately sounded at present; even intelligence, as extensively and intensively as it has been worked on, seems now to be breaking down into a number of identifiable factors. Nevertheless, in spite of deficiencies and the need for caution, it seems probable that social placement attempts are going to be made. Certainly these efforts at conjunction of talents and tasks should follow the latest scientific developments, and we have here a contribution toward that end.

MARTIN F. FRITZ

Iowa State College

Old-Age and Survivors Insurance Statistics, Employment and Wages of Covered Workers, 1938. Washington: The Social Security Board. 1940. xxiii, 208 pp.

The federal old-age insurance program established by the Social Security Act in 1935 and amended in 1939 provides for old-age and survivors benefits related to wages earned by individuals in covered employment, and thus requires vast bookkeeping. Each dollar of wages (up to $3,000 during a calendar year) paid in covered industries must be reported by employers to the Treasury, then by this Department to the Accounting Operations Division of the Bureau of Old Age and Survivors Insurance of the Social Security Board, and credited to the account of the respective wage earner. Nearly 50 million individual accounts continuously carried by the Board constitute a current record of earnings of the majority of the working population of the Nation.

With the extension of the program to the occupational groups now excluded—such as employees of non-profit organizations, agricultural labor, domestic servants, and self-employed—this record will become a Nation-wide accounting of earnings and incomes. The combination of inclusive earning statistics with personal characteristics of the earners makes possible cross-classifications of all kinds. Wage statistics based on voluntary reports of selected firms not necessarily typical of industry as a whole have become obsolete. Trustworthy bench marks are provided for checking current employment statistics and estimates of the flow of national income. These all are reasons enough for statisticians to watch the social security statistics grow!

With the issue of this book, selected statistics derived as a by-product of the operation of the Bureau of Old-Age and Survivors Insurance are now released for public use. More than 26 billion dollars of taxable wages earned in 1938 by approximately 31 million individuals are classified here by wage intervals, sex and age of earners, number of calendar quarters with wage

credits, state, and industry. For 13 states special tables for Negro and non-Negro workers have been prepared. The emphasis is on two problems: continuity of covered employment and differentials in structure of earnings by industrial divisions.

To the 1938 tabulations which constitute the bulk of the volume are added tables for the year 1937 which stress mainly state differentials in wages and interstate migration of covered workers.

Methodological limitations of the new tabulations, their place in the system of American statistics, questions which they are likely to clarify, and new problems which arise, cannot be discussed in this brief note. The reviewed publication opens a new page in the history of American statistics and is recommended to the particular attention of students in labor economics.

W. S. Woytinsky

Committee on Social Security of the
Social Science Research Council

Methods of Assessing the Physical Fitness of Children, by Rachel M. Jenss and Susan P. Souther. Washington, D. C.: Children's Bureau Publication No. 263. 1940. vi, 121 pp. 15 cents.

In any program for improving the physical condition of children an important factor is a practicable procedure to indicate those children who are most in need of attention. In an attempt to develop an easily applied method of assessing physical fitness, various indexes of body build have been devised, based on the relation of weight or girth of arm to age and height or to age, height, and some lateral measurement. This study is an evaluation of four of these indexes: The Baldwin-Wood Tables, the A C H Index, the Nutritional Status Indexes and the Pryor Width-Weight Tables. It is based on observations made on 713 seven year old school children of New Haven, Connecticut.

The criteria used in evaluating the four indexes were based on a clinical judgment of poor or very poor nutritional condition made by a pediatrician, on a low rate of growth in weight or girth of arm or on a combination of the two elements. All the indexes were found to lack both sensitivity and specificity: that is, many of the children whose condition was indicated by the criteria as unsatisfactory were not picked out by the index and conversely many of the children whose condition was indicated by the criteria as satisfactory were picked out by the index as unsatisfactory. There was also considerable disagreement in the clinical judgments of different pediatricians.

John R. Miner

Mayo Clinic

Controlled Fertility, An Evaluation of Clinic Service, by Regine K. Stix and Frank W. Notestein. Baltimore: The Williams & Wilkins Company. 1940. xiv, 201 pp. $3.00.

Because the field is a focus of study for persons trained in a number of traditional disciplines, population problems are being subjected to a convergence of varied approaches and research techniques. In this advancing field *Controlled Fertility*, by authors with different types of training, provides a model of monographic excellence both with respect to method and with respect to importance of findings.

A listing of the methodological virtues of the study reads like an outline of tenets advised in every course in methods of research, but seldom heeded so meticulously. First in evidence is careful design of the study to secure the desired information; next, the gathering of data by an expert (Dr. Stix); next, the thorough statistical analysis of data with well constructed tables and graphic forms for presentation of results; next, interpretation of the results both in reference to the specific inquiry and in reference to their broader implications; and finally, especially pleasing to the statistician, appendices which explain procedures so precisely that anyone could follow them and compute from similar data comparable pregnancy rates or ratios of effectiveness of contraceptive techniques.

The most important specific finding of the study is that major attention should be given to the *acceptability* of contraceptive methods rather than to the *potential effectiveness* of methods when correctly used. The implication of this finding is that more flexible clinic policies and programs are needed. Other interesting findings are suggestive evidence that there has been no decline in biological fecundity since 1890; that there is no lessening of fecundity caused by the use of contraceptives; that the great decline in the birth rate has been effected by the increase in use of folkway methods of contraception; and that birth control clinics have played a relatively minor rôle in disseminating contraceptive information in the United States.

In keeping with the broadening concept of the content of population programs, the authors use their evidence to point to the necessity of other features than birth control in a realistic population policy. They believe that the will to reduce fertility among the depressed groups of our population will come only in response to broad changes in living conditions; that birth control has small chance for success as an isolated movement, but instead should be an indispensable part of an integrated crusade for better living.

MARGARET JARMAN HAGOOD

University of North Carolina

Population, Births, Notifiable Diseases, and Deaths, assembled for New York City, N. Y.: 1866–1938—Planned by Haven Emerson, M.D., and executed by Harriet E. Hughes. New York: The DeLamar Institute of Public Health, College of Physicians and Surgeons, Columbia University. January, 1941.

One cannot help but be impressed by the mass of data contained within the pages of this volume of tabulations. All but 12 of the 400 pages of the com-

piled vital statistics data for New York City are devoted to morbidity and mortality tabulations covering a 72 year period. Morbidity (for notifiable diseases only) and mortality data for each cause of death are presented in three basic tabulations—namely, cases of diseases reported by week, deaths reported by week, and deaths by age and sex for the years that data have been available during the period, 1866 to 1938.

According to the authors, there is no other source of "authentic information for the vital statistics of New York City from 1866 to 1938." This report therefore represents a unique contribution from that point of view. The tabulations are of unquestionable value for some purposes but other considerations make it difficult to make an appraisal of the data as a reference source. Perhaps the most serious of these considerations is the use of the 1929 International List of Causes of Death in presenting statistical data for the entire 72 year period. Although the authors state that certain adjustments were made in an attempt to maintain statistical comparability through the various decennial revisions of the International List, it is obviously impossible in many cases to preserve comparability when separate titles are used. There is, however, no evidence to indicate that the closest practical approach to comparability was not achieved, but it is unfortunate that the authors did not discuss fully the manner and method in which the tabulations were made in order to make the data as comparable as possible.

Data were obtained from over 100 different reports in the preparation of this volume. While it is admittedly impractical to indicate the source of each figure in the volume, some reference should be made to the original reports from which the data were compiled.

In the introductory remarks, the authors point out the incompleteness of morbidity reporting. They also explain some of the reasons for certain discrepancies between the weekly number of cases of disease and the weekly number of deaths reported for the corresponding disease and state that, "Errors of diagnosis, delay in reporting, and other factors involved in current records by weeks or months of the communicable diseases are responsible for the slight differences in the number of deaths ascribed to the disease on the two sets of sheets." No specific mention, however, is made of an equally important cause, the fact that the two sets of weekly data do not necessarily refer to the same population since there is generally a variable period of lag between the time when a case is reported and when death ensues. This and the other limitations already mentioned make it impossible to calculate case-fatality rates on a weekly basis as one first hopefully supposes in finding the weekly morbidity and mortality data arranged side by side.

In summary, it may be said that this report represents a worthy effort to bring together in one volume certain tabulations relating to population, birth, morbidity and mortality data. The compilation is not without its defects, but these might be partially overcome by a more thorough evaluation of the data. It is not possible to present adequately vital data covering a long time period, without qualifying in detail the gaps which are inevitably

present. It is to be hoped that the authors in some future publication will present a discussion of the manner in which the data were compiled, their source, and limitations. If this were done and published, perhaps as an appendix, the present volume would assume greater value.

HALBERT L. DUNN

U. S. Bureau of the Census

Statistical Methods for Medical and Biological Students, by Gunnar Dahlberg. New York: Interscience Publishers, Inc. 1940. 232 pp. $2.75.

In his preface and introduction, the author mentions the increasing use and appreciation of statistical methods in the medical and biological sciences. The desirability of extending the application of statistical methods is emphasized. The book is presented as an elementary, non-mathematical exposition of statistical procedures to assist in furthering this much to be desired objective.

A perusal of this textbook will not lead most medical students in this country to classify it as non-mathematical. It contains much in the way of elementary algebra and mathematical logic that will require on the part of the beginning student careful attention and considerable determination if they are to be mastered.

It would hardly be possible to reduce further the mathematics included and give much of an idea of the bases of statistical procedures. The author's "compromise between the demands of the mathematical statistician and the mathematical limitations of the medical and biological student" compares well with the many attempts made to solve this problem as illustrated by the numerous elementary textbooks on statistics that have appeared in recent years.

The first three chapters deal with probability, combinations, and the binomial theorem. Next come chapters dealing with methods of handling quantitative data, including the calculation of averages, the measurement of variation, the comparison of samples, and the evaluation of correlation as applied, in the main, to large samples. In discussing correlation, the tetrachoric coefficient of correlation is briefly described, a somewhat unusual selection for an elementary book.

The methods of analyzing qualitative data and of determining the goodness of fit are discussed, though additional practical applications of the chi-square test might well have been included. Space is not devoted to such subjects as rates, life tables and their construction, registration methods, and population problems generally classified under vital statistics.

The book is clearly written in an interesting style, and the illustrative data used should be of interest to medical and biological students.

GAIUS E. HARMON, M.D.

Detroit Department of Health

Statistical Methods Applied to Experiments in Agriculture and Biology, by George W. Snedecor. Ames, Iowa: Iowa State College Press. Third Edition. 1940. xiii, 422 pp. \$3.75.

Since the first editions of this book have been extensively reviewed, it is not necessary to deal with the main body of the text. In the third edition, several additions have been made that are of considerable value. Two short sections have been added to the chapter on linear regression. These are entitled, "Regression and rates," and "The standard error of a forecast." The title of the latter section may be misleading to some in that the section actually deals with standard errors of values that have been adjusted by linear regression equations. In many cases this is not strictly a matter of forecasting. It is unfortunate that there are mistakes in the formulas of this section. On line 8 of page 122, Sx^2 has been omitted as the divisor of $(\bar{x}_k-\bar{x})V_{y\cdot x}$, and in four places on the same page minus signs should be plus signs.

The re-written section on "Test of homogeneity of variance in several groups" is extremely useful, as this is becoming a standard procedure in many projects requiring statistical analysis. Another new section has to do with transformations of data for tests of significance. This is also very timely as there is undoubtedly a good deal of confusion as to the need for transformations and how they should be made. The explanations are clear and logical and the necessary tables are given.

The chief addition to the book is an entirely new chapter "Design and Analysis of Sampling." This is a subject which is not dealt with in most books on statistical analysis and there seems to have been an impression that modern statistical methods, as exemplified chiefly by the analysis of variance technique, do not have a direct bearing on sampling problems. Snedecor illustrates how the principles of the analysis of variance throw a great deal of light on problems of this type. This chapter is excellent; the only suggestion that might be made is that stricter editing of the first few pages would have contributed to greater clarity of statement.

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Statistica Economica con Riferimenti alla Organizzazione e alle Fonti, by Giovanni Lasorsa. Cedam: Casa Editrice Dott. Antonio Milani. Padova: 1940. vii, 405 pp. 63 lire.

This textbook has apparently the following objectives: 1) to list and describe the principal official sources of data about the economic resources and activities of Italy and other countries; 2) to consider critically the validity and comparability of data collected in different countries; and 3) to outline some very elementary techniques of statistical elaboration of the data. These

objectives are sufficiently well realized in the exposition of the subject matter which is segregated under two main headings: census of economic enterprises and statistics of economic activities. The first part is concerned with the methods employed in surveys of agriculture and industry. The census forms devised by the International Institute of Statistics are presented in detail together with the modifications introduced in certain countries. The results of the census taken about 1930 in 21 countries are compared relative to land in use, and livestock. With reference to industry, the discussion centers principally on the methods and results of the Italian censuses of 1927 and 1937–39. Some comparisons of a very general nature are made with the recent findings reported in other countries. The second part of this work is devoted to the measures of fluctuations and trends in stocks of goods, money, prices, consumption, and international commerce. In this section much emphasis is given to the need for careful scrutiny of the reported data because of the well-known inconsistencies manifest in the techniques of collecting such information. The author evaluates clearly the merits of several procedures to render more meaningful the available data and comparisons between countries. To this end, reports and studies published under the auspices of the League of Nations or of the International Institute of Statistics are reviewed. The findings discussed are familiar to most students of economics but some tabulations particularly those relating to the food supplies of Italy deserve to be given greater attention in view of the present international conditions. Lasorsa's figures bring out that from 1922 to 1937 Italy succeeded in reducing its food requirements from foreign countries, and that while the situation with reference to supplies of carbohydrates and protein was in 1937 not unfavorable the need for foreign fats has continued to be the weakest point in Italian economy.

Although the author's attention is focussed mainly on the status of Italian statistics, he has also taken into account the progress of ideas on the subject in other countries. Within its limits as an elementary treatment of the initial aspects of statistical technique this textbook is of the first order. It does not include, however, a bibliography.

ANTONIO CIOCCO

National Institute of Health

Punched Card Methods in Scientific Computation, by W. J. Eckert. New York: The Thomas J. Watson Astronomical Computing Bureau, Columbia University. 1940. ix, 136 pp.

A long-felt need for an exposition of the statistical (as opposed to the accounting) possibilities of punched card equipment is partially satisfied by this able, somewhat specialized monograph. Dr. Eckert, now Director of the U. S. Nautical Almanac Office, at the time of writing represented Columbia University's Astronomy Department and Rutherfurd Observatory on the Watson Bureau, which is jointly sponsored by the American Astronomical

Society, the International Business Machines Corporation (whose president is Thomas J. Watson), and Columbia University. Inevitably, the non-astronomically inclined (including the reviewer) will find some translation necessary in applying these methods to their own research; nevertheless this monograph contains the best statement of the basic operating principles of the Hollerith punched card method, and the best summary of available equipment and of the tasks it is designed to perform, of which the reviewer is aware.

The general reader will find especially helpful the suggestions for short cuts and more efficient use of various pieces of equipment, special sorting techniques, and the careful exposition of the method of progressive digiting (whereby product sums may be obtained quickly and inexpensively from sorter and tabulator, if the individual products are not required). Also of general interest are: the construction of card files which constitute tables of tabular functions, the use of the multiplying punch to perform LaGrangian interpolation and of the tabulator to accomplish interpolation by differences, the multiplication of series, harmonic analysis, and numerical integration. The chapters entitled "The Calculations Involved in the Construction of Catalogue of Photographic Star Positions," "Stellar Photometry," "Numerical Lunar Theory," and "The Computation of Planetary Perturbations," are likely to prove somewhat esoteric, however.

The description of the various punched card machines and their plugboards is good, though brief, and is sufficiently modern to include the Collator. The Bureau is evidently not equipped with an alphabetic tabulator, but this is not surprising in view of the special nature of its work. For those workers who require the greater versatility of the alphabetic as opposed to the numeric tabulator, the slight mention of the former will be a disappointment. Because of the similarity of the two machines in principle, this is not, however, a major omission. In the reviewer's opinion this is a "must" book for any statistical bureau using Hollerith equipment in scientific work.

FRANCIS MCINTYRE

Indiana University

Graphs, How To Make and Use Them, by Herbert Arkin and Raymond R. Colton. New York: Harper & Brothers. Revised Edition. 1940. xvi, 236 pp. $3.00.

The 1936 edition of this book was reviewed in the September, 1936, issue of this JOURNAL. The changes in the new edition are minor and relatively unimportant. A five-page chapter on graphic layout is added to improve the continuity of the early part of the book. A few new charts are included, but the numbering has not been disturbed since these are assigned numbers 7a, 38a, etc. Although the changes made are generally in the direction of improvement, in places the facing page has been shifted so that the discussed charts are inconveniently placed (notably see pp. 55–56).

This book fills a distinct niche in the statistical literature. It is simply written and covers as wide a range of topics as any person other than the expert is likely to find of interest. The emphasis is on chart construction and from the point of view of elementary practice it has no equal in this respect. The intended character of the book is such that the reasons for using procedures are included only if they can be stated simply. Therefore, parts of the book are less thorough than the chart discussion in elementary textbooks on statistical method.

Several accomplishments may properly be expected from a book on graphs—notably, illustrations of types and explanation of their uses, comparative advantages of different types, the best methods of construction, recognition of illusion, and presentation standards. The book in review scarcely touches on the illusion problem. On standards the 1915 codification is appealed to, and no reference is made to the important work of recent years done by the American Society of Mechanical Engineers, the American Society for Testing Materials, and the American Standards Association. The comparative advantages of different charting methods are given too little consideration.

Elmer C. Bratt

Lehigh University

Building Cycles and the Theory of Investment, by Clarence D. Long, Jr. Princeton, New Jersey: Princeton University Press. 1940. xvi, 239 pp. $2.50.

The current importance of studying the great cycles of business activity which seem to characterize certain industries is widely recognized, but those who have attempted such studies have found great difficulty in bringing the necessary materials together. This book will be welcomed by students of cycles as a real contribution to the literature on the subject. As the basis of his study Dr. Long has made an exhaustive search of the literature of the field, and he has presented the outstanding points in summary form in this volume. He has also made new compilations of data from original sources and he represents three sets of long-term building data, namely: Annual indexes of value of five classifications of building, 1868–1935; annual indexes of number of three classifications of building, 1856–1935; and a monthly index of building, 1868–1940. The theory of investment is handled as a development of the investment-consumption interaction, with attention to many factors, including elasticity of demand for houses, the growth of speculation, the increase in the use of mortgage credit, and the association of cycles in building and stock prices.

Numerous instances of conflicting opinions or doubtful conclusions are cited and both sides of the questions are analyzed. The treatment of the many questions is such that the reader should be encouraged or inspired to undertake further study. The paragraphs, for example, on "The Lag of Building Recovery," "The Lead of Building in Depressions," and "Why

Cycles in Building are Long," suggest many fields for worthwhile investigation. The difficulties regarding statistics, particularly those of costs, are pointed out, and the author is careful to indicate that he does not expect too much from his statistics. For the economist and for the practical business man, who wish a summary of the work that has been done with new material expanding the work and bringing it up to date, together with well applied straightforward analyses of the factors involved, this book will serve a long felt need.

John R. Riggleman

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U. S. Department of the Interior

Great Britain under Protection, by Frederic Benham. New York: The Macmillan Company. 1941. xvi, 271 pp. $2.50.

Dr. Benham's book is one of a series which is planned to cover the recent tariff history of the principal European countries. The series is sponsored by the Carnegie Endowment for International Peace and is edited by Dr. Florinsky. As judged by this first volume, students of international trade and finance policy should find the series to be a helpful source of information.

The book deals mostly with events since 1931. According to the author, Great Britain became definitely protectionist with the Import Duties Act of 1932. The shift in British policy from free trade to protection is presented in the first chapter as a rather sudden change precipitated by the world-wide depression. The analysis, however, of the British tariff and other forms of protection in the next two chapters indicates that several significant changes occurred prior to that date; namely, the McKenna Duties of 1915, the Dyestuffs Act of 1920, the Key Industry Duties of 1921, the Sugar Subsidy of 1924, etc. These changes were primarily connected with national defense—a factor which the author fails to discuss in chapter one.

A short discussion of British tariff-making provides an interesting contrast with American practice. Changes in the tariff are made mainly by the Import Duties Advisory Committee. The account of imperial preference and the British trade agreements establishes several important points; namely, the limited possibilities of confining trade within the Empire, the British insistence on most-favored-nation rights which prevented the formation of low tariff unions among various countries, and the signature in 1938 of the Anglo-American trade agreement which indicated a turn towards a more liberal trade policy. Protection with regard to the iron and steel industry and agriculture is analyzed in detail in chapters VII and VIII. The other three chapters are devoted to monetary policy, economic recovery, and to concluding statements. A useful statistical appendix is included.

The author concludes that British trade and exchange policy improved temporarily the export situation, that the tariff assisted British economic recovery, and that "the main cause of the recovery was perhaps the low

prices of imported foodstuffs" (p. 247). This analysis of British recovery, especially of the rôle of monetary policy, does not seem adequate to the reviewer. It certainly is not improved by the unsupported comments of the author with regard to dollar devaluation (p. 161) and by the immoderate repetition of these comments by the editor.

CLIFFORD L. JAMES

Ohio State University

Maps of Selected Industries Reported at the Census of Manufactures, 1937. Washington: U. S. Bureau of the Census. 126 pp. $1.00.

This is a folio containing 117 maps for selected leading manufacturing industries, notably those of particular importance to the national defense program. The mapping of the selected industries resulted from a cooperative study by the Bureau of the Census and the Bureau of Agricultural Economics. Maps for some of the industries were prepared at the request of the Advisory Commission to the Council of National Defense.

Three maps are presented for each of 39 industries. The first map shows the distribution of the establishments in the selected industry, by counties. The second map shows the approximate number of industrial wage earners employed in the particular industry by counties, as indicated by shading or ruling for five categories. The third map shows the approximate size of the industry in terms of dollars of value added by manufacture, again for five class groups.

The limits for the wage-earner and value-added categories have been set wide enough so that information can be given for all counties in which an industry is represented without running afoul of the disclosure rule which forbids the Bureau of the Census to reveal the data of a given establishment. In spite of this rule the Bureau has been able to present figures which show for all parts of the country whether an industry is of minor, small, medium, considerable, or great importance. Such efforts will doubtlessly result in much wider use of the regional data.

There is printed at the side of each map, with a few exceptions, the name of every county for which data are indicated. The county names (listed by states) are numbered and corresponding numbers are printed beside each county area shown on the map, except for certain unintentional omissions and except for industries so widespread that such detail cannot be presented. The county numbering system is not the same on the three maps for some industries. It would have been easier to follow the set of maps in these cases to obtain the information available, if it had been possible to identify each county by the same number. In some cases two or more adjacent counties are grouped together as a single shaded or ruled area on the wage-earner or value-added maps. It is important to note in such cases that each of the counties, rather than the combined group, falls in the indicated category. This and other explanatory information on the use of the maps should have been included.

The maps in this folio are useful to show at a glance the relative concentration and dispersion of establishments in the selected industries; also to show the relative employment and production in these industries. The maps should be of especial value to those who are concerned with problems regarding the location of industries. Mr. Harold D. Kube of the Bureau of the Census and Mr. Ralph H. Danhof of the Bureau of Agricultural Economics should be congratulated for planning and developing such a useful folio of maps.

OSCAR L. ENDLER

National Resources Planning Board

Tinrestrictie en tinprijs (*Tin restriction and tin price*), by M. J. Schut. Haarlem: De Erven F. Bohn N. V. 1940. xii, 115 pp.

Most of the quantitative studies of the laws of supply and demand of raw materials relate to agricultural products. The present study of the dynamics of the international tin market is very welcome as an extension of the methods of these studies to a mining product.

The purpose of the investigation is to provide a quantitative basis for estimating the effects of the international tin restriction scheme, which has been in operation since 1931, on the level and stability of tin prices. To that end a systematic study is made of the factors determining consumption, production, and the price of tin, using statistical series usually beginning about 1920 but in some cases going back to 1904.

The demand for tin appears to be dependent to a greater extent on the activity in the various industries in which it is used than on its price. This conclusion, already suggested by the small contribution of the cost of tin to the cost of the principal final products, is confirmed by multiple regression analysis.

The price of tin is mainly determined by the size of world tin stocks, with the rate of increase in stocks exercizing a subsidiary influence. The explanation of the influence of the volume of production, required to complete the picture, meets with considerable difficulties which are connected with differences in degree of mechanization and in reaction to prices as between the several tin production processes.

In the various statistical analyses the reader is sometimes left with a choice between two or more mutually exclusive explanations. The alternative theory explaining production essentially as carried out "on order" and therefore directly determined by demand indeed makes changes in stocks an irrelevant random variable, and is therefore incompatible with the important rôle properly assigned to fluctuations in stocks in the mechanism of the market. Similarly, in the explanation of tin consumption, a table giving the proportion of total consumption assignable to automobile and tin-plate production as less than 50 per cent is followed by a regression analysis making fluctuations in production in these two lines responsible for all fluctuations in demand other than those due to changes in price.

The discussion of the influence of the restriction scheme is very instructive in that it illustrates a type of argument which is the only recourse when the statistical basis is deficient in certain respects. One rather uncertain coefficient, the elasticity of supply, is given several tentative values in order to show that the particular conclusion drawn is valid for a wide range of values assumed by this coefficient. The conclusion is that in the absence of the restriction scheme the tin price would have remained for several years on a level unremunerative at least for the not completely mechanized producers.

TJALLING KOOPMANS

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Wheat Studies of the Food Research Institute, Stanford University, California.
"World Wheat Survey and Outlook, September 1940," by Helen C. Farnsworth and V. P. Timoshenko. Volume XVII, Number 1. September, 1940. pp. 1–38. 75 cents.
"Wheat Subsidization and Exports, The Experience of 1938–39," by V. P. Timoshenko. Volume XVII, Number 2. October, 1940. pp. 39–110. $1.00.
"Price Relations of Liverpool Wheat Futures With Special Reference to the December–March Spread," by Sidney Hoos and Holbrook Working. Volume XVII, Number 3. November, 1940. pp 101–144. $1.00.
"The World Wheat Situation, 1939–40, A Review of the Crop Year," by Joseph S. Davis. Volume XVII, Number 4. December, 1940. pp. 145–220. $1.25.

Two of these monographs deal with the world wheat situation during the crop year 1939–40. These annual objective studies are of great service towards the understanding of market phenomena and especially of price movements. In this particular year the large carry-over and crop, the new great war, domination by a few governmental agencies, and unpredicted changes in crop conditions both in Argentina and the United States were factors of major importance in the history of the crop year. The problem of accurate advance estimates of world supply is dramatically illustrated by both private and official data for 1940. On the average the estimates for 1933–38 changed little as the seasons advanced, but the December 1939, estimates were only two-thirds or less of actual harvests. Other marked changes in estimates are noted for 1917, 1920, and 1930. This is one important source of explanation of seasonal price fluctuations that occur in the grain markets and that I discussed before the Association meeting at Chicago in December 1940 (*Journal of Marketing*, April, 1941).

The other two monographs deal with special phases of wheat-market phenomena. Timoshenko describes and evaluates the many government interventions and the various schemes of wheat subsidization as they actually operated in 1938–39. The two previous years had shown little in the way of governmental control apparently because of short world crops, but in the year here under study practically all principal countries re-established their

controls. That competitive subsidization would have continued at high cost in 1939–40 appears likely had it not been for the European war. Some subsidization did continue, but in modified form. Timoshenko concludes that the experience with competitive export subsidization in 1938–39 gives little support for this approach to the problem of export surpluses of wheat. One is reminded, also, of Woodrow Wilson's remark in 1908: "Regulation by commission is not regulation by law, but control according to the discretion of governmental officials."

Hoos and Working present another excellent example of statistical analysis of price movements and relationships. Their study of Liverpool wheat futures supplements an earlier study of Chicago futures. The present reviewer finds, however, that in some respects this study leaves him cold. Market price in a market of this sort must be the result of decisions of buyers and sellers. At best, the moderate correlation found between certain measured supply-and-demand conditions and price relations is indirect evidence that buyers and sellers were led to their decisions by these conditions. Whether or not buyers and sellers really use these criteria could perhaps be answered more directly by the large operators themselves. Perhaps, however, the purpose of the study is to show what the authors believe "should" be considered by buyers and sellers. If that is the purpose, then the study seems to me still wider of the mark. I hope that some day students of market price can find a method of direct measurement of the things that lead individual buyers and sellers to make specific transactions. Once such information becomes available it may be possible to understand market phenomena.

ROLAND S. VAILE

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Wartime Control of Prices, by Charles O. Hardy. Washington, D. C.: The Brookings Institution. 1940. x, 216 pp. $3.00.

In this study, Hardy has given us a thoughtful and lucid analysis of wartime price problems; it should be welcomed by non-technical readers as an intelligible survey of a difficult subject and by economists as an admirably balanced account of price control policies. The reviewer recalls no other book in the past decade, with the possible exception of Slichter's *Towards Stability*, which has the same combination of sound scholarship, extensive coverage, popular style, and avoidance of a doctrinaire position. Intelligent people with no background in economic analysis ask with increasing frequency for help in understanding price and fiscal problems and the proposals for government action in the area. Hardy's book seems to be an almost perfect answer to such questions.

A seventeen-page introduction, which might well be reprinted in pamphlet form for wide distribution, contains a summary of the analysis on problems in price control presented at length in Part I. Successive chapters,